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Science & Technology

***USSR: Physics &
Mathematics***

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SCIENCE & TECHNOLOGY
USSR: PHYSICS & MATHEMATICS

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USE OF BOUNDARY-LAYER METHOD FOR PROBLEM OF SOUND PROPAGATION THROUGH CHANNEL WITH VARIABLE CROSS-SECTION CONTAINING STREAM OF FLUID

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 18 Jun 86) pp 212-218

[Article by A. F. Gladenko and Ye. A. Leontyev]

[Abstract] Propagation of sound through a rigid cylindrical channel with a smoothly and only slowly varying cross-section containing a fluid in motion is analyzed by the boundary-layer method according to the classical theory of diffraction, this method being modified here for the situation of particular interest where in some channel cross-section the frequency of sound is equal to the critical frequency. The procedure, based on waveguide solutions to the Blokhintsev equation for the total enthalpy with appropriate boundary conditions, leads to a system of equations for two functions ρ, θ which must satisfy a system of equations equivalent to equations of the eikonal for the moving fluid and yields asymptotic expressions for the parameters of acoustic modes in such a channel. The results are consistent with known results for a channel containing fluid at rest. References 7: 6 Russian, 1 Western.

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LINEAR THEORY OF GENERATION OF LONGITUDINAL SOUND WAVES IN SEMICONDUCTORS UPON INTERBAND ABSORPTION OF OPTICAL RADIATION

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 25 Jul 86) pp 223-232

[Article by V. E. Gusev and Ye. G. Petrosyan, Department of Physics, Moscow State University imeni M. V. Lomonosov]

[Abstract] A consistent mathematical theory is developed describing optical excitation of longitudinal sound waves in semiconductors. It includes two possible crystal deformation mechanisms, namely deformation owing to thermal expansion and during photogeneration or recombination of charge carriers. The theory is based on the one-dimensional nonhomogeneous wave equation for the

vibrational velocity potential. Solution of this equation involving a Fourier transformation with respect to time and a Laplace transformation with respect to the space coordinate yields, assuming negligible absorption of sound waves, the vibrational velocity of a traveling sound wave. A simple model is used for describing the kinetics of photoexcited charge carriers and of lattice heating, with appropriate boundary conditions at the point $x=0$. The exact solution to the two equations of this model yields the spectrum of acoustic pulses and reduces to a simple form by virtue of a strong inequality between the three relevant characteristic lengths $\lambda_T \ll \lambda_D \ll \lambda_A$ (λ_T - length of thermal wave, λ_D - length of diffusion wave, λ_A - length of acoustic wave). The solution is then analyzed in four different regions with the distance of light absorption $L \gg \lambda_D$ and namely where $L \gg \lambda_A$, $\lambda_D \ll L \ll \lambda_A$, $\lambda_T \ll L \ll \lambda_D$, $L \ll \lambda_T$ respectively. The authors thank S. A. Akhmanov for support. Figures 2; references 21: 14 Russian, 7 Western.

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BJERKNES INTERACTION FORCE OF TWO GAS BUBBLES IN FIELD OF SOUND WAVE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 24 Mar 86) pp 240-245

[Article by S. T. Zavtrak, Scientific Research Institute of Applied Physics imeni A. N. Sevchenko, Belorussian State University imeni V. I. Lenin]

[Abstract] Bjerknes interaction of two gas bubbles in an incompressible fluid excited into pulsations by a sound wave is considered in the acoustic approximation, assuming that the distance between their centers in equilibrium is much smaller than the wavelength of sound and the velocities of their oscillating surfaces are much smaller than the velocity of sound in both liquid and gaseous phases inside these bubbles. The interaction force is calculated exactly, including multipole components which distort the surfaces of bubbles from an otherwise spherical shape. The velocity potential is obtained from the Gromek-Lamb equation of motion, through an infinite system of integral equations which yields a system of four recurrence relations for the coordinates of sources and sinks. For the simplest case of two identical bubbles relations are obtained for energy dissipation, with computer-aided tabulation of special functions, for the force necessary to overcome viscous forces, and for losses due to departure from adiabaticity. Tables 1; references 10: 9 Russian, 1 Western (in Russian translation).

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ATTENUATION OF ULTRASONIC WAVES IN NONMAGNETIZED MAGNETIC FLUIDS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 10 Jul 86) pp 256-260

[Article by I. S. Koltsova, Leningrad State University imeni A. A. Zhdanov]

[Abstract] An experimental study of ultrasonic waves propagating through non-magnetized magnetic fluids, suspensions of nearly spherical iron particles with a radius of the order of 50 \AA and an approximately 20 \AA thick surfactant coating in kerosene, was made for a quantitative evaluation of the wave attenuation mechanism which adds to the acoustic absorption mechanism. The corresponding second loss coefficient characterizing transfer of energy during interaction of an ultrasonic wave and an inhomogeneity in the medium with attendant additive excitation of shear, viscous, and thermal waves was measured as a lump sum of the respective component coefficients over the 0.1-3.5% range of particle concentration and the $2 \cdot 10^5$ - $3 \cdot 10^7$ Hz range of ultrasonic frequency. It was measured by the reverberation method at the lower frequencies of $2 \cdot 10^5$ - $3 \cdot 10^6$ Hz and by the pulse method with variable distance at the higher frequencies of $3 \cdot 10^6$ - $3 \cdot 10^7$ Hz. The experimental results confirm theoretical predictions regarding the concentration dependence and the frequency dependence of this second attenuation coefficient, those predictions being based on individual analysis of all wave excitation mechanisms and characteristics. Accordingly, the second attenuation coefficient depends linearly on the particle concentration and quadratically on the wave frequency until relaxation begins above 10^6 Hz so that its frequency dependence becomes weaker. Figures 3; references 10: 8 Russian, 2 Western.

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AVERAGE CHARACTERISTICS OF FIELD PRODUCED BY LONG SOURCE IN UNDERWATER ACOUSTIC CHANNEL

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 19 Mar 86) pp 261-266

[Article by Yu. A. Kravtsov and V. M. Kuzkin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Long and narrow antennas in an acoustic channel with absorbing lower boundary and ideally soft upper boundary are considered, the object being to determine the average law of field attenuation away from such a source. The fundamental expression for the field intensity within the Fraunhofer region as

a function of the distance yields, in the case of a vertical linear antenna in a horizontal underwater channel, significant departure from the "three halves" inverse law toward a simple inverse law. The directivity of such an antenna in the approximation of small sliding angles and the dependence of average field characteristics on the antenna radiation pattern are evaluated, for the purpose of antenna design analysis and optimization. The results reveal that for every distance from the antenna there is a minimum antenna length which yields a gain approaching the maximum attainable, namely

$q_{\text{opt}} \approx 1/2\sqrt{\pi} q_{\text{max}}$. The authors thank V. I. Talanov for stimulating discussion and Yu. P. Lysanov for valuable critical comments. Figures 3; references 7: all Russian.

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SPACE-TIME PROCESSING OF FIELD PRODUCED BY MOVING SOURCE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 29 Aug 86) pp 281-286

[Article by D. Ye. Leykin, Institute of Acoustics imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] Space-time processing of a scalar wave field for detection of a moving signal source is analyzed by representing such a field as an additive mixture of signal and interference in the space-time domain. The signal is assumed to come from a point source of stationary Gaussian noise moving in a homogeneous free space along a sought trajectory. A detection algorithm which includes weighting with respect to variations of signal parameters is constructed on the basis of sufficient statistics. Its sensitivity to signal parameters including those of motion of the source is characterized by the signal-to-interference ratio and is determined with the aid of the generalized uncertainty function, the latter having the structure of the normalized signal-to-interference ratio. This function is calculated for signals whose spectra are wider or narrower than the frequency resolution and than possible Doppler shifts, also for a signal with a continuous spectrum containing a narrow spike. The results indicate the necessary focusing characteristics of a stationary space-time processing receiver antenna and can be extended to a moving one. The author thanks A. S. Yakunichkin for attentiveness and helpful comments. References 2: 1 Russian, 1 Western (in Russian translation).

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MODELING SPACE CORRELATION AND INTENSITY OF LOW-FREQUENCY SURFACE NOISE ON DEEP SEA

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 29 Aug 85) pp 307-311

[Article by B. A. Niyazov, Tashkent State University imeni V. I. Lenin]

[Abstract] The space correlation function and the acoustic field-intensity distribution of surface noise on an oceanic waveguide are calculated analytically by the asymptotic methods, assuming that the noise sources are located in a horizontal plane below the ocean surface at a distance much smaller than the wavelength and thus far above the ocean bed. The analysis is based on the model of multiple refraction with a vertical profile of acoustic velocity characterized by a minimum at some depth in the water but remaining uniform in the bed. The space spectrum of noise sources is assumed to be azimuthally uniform. Total attenuation of noise is treated as a result of sound absorption by water and by the bed, additively, but absorption by the bed being so much more appreciable that only the acoustic field in the water needs to be considered with the wave function in the Wentzel-Kramers-Brillouin approximation. The amplitude of the oscillatory noise intensity component is found to increase toward the ocean surface, but so that total noise intensity becomes zero at the surface. Figures 2; references 10: 7 Russian, 3 Western (1 in Russian translation).

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MODIFIED KIRKWOOD-BETHE APPROXIMATION FOR CALCULATING TOTAL PROFILE OF DETONATION WAVE AND ITS SPECTRUM NEAR SOURCE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 6 Mar 86) pp 317-323

[Article by Yu. V. Petukhov, Institute of Applied Physics, USSR Academy of Sciences]

[Abstract] The problem of underwater detonation is considered in its entirety beyond the shock wave, namely including subsequent pressure pulses caused by oscillations of the active gas bubble. An adequate approximation is sought for correctly calculating, by numerical means, the total profile of a detonation wave on the basis of the Kirkwood-Bethe hypothesis of a $G = r^j(w + 1/2 u^2)$ function invariant along a $dr/du = c + u$ characteristic (r - distance from center of charge, w - enthalpy, u - velocity perturbation in wave, c - constant, $j = 1$ for spherical detonation or $j = 1/2$ for cylindrical detonation). Such an

approximation is found upon stipulation of two sets of boundary conditions: one for velocity and pressure at the shock wavefront, one for pressure and velocity perturbations at the bubble surface. Solution of the corresponding equations of gas thermodynamics by numerical integration on the basis of this modified Kirkwood-Bethe approximation yields not only the wave profile and its evolution but also the dependence of the spectral energy density and of the momentum in a shock wave on the depth of detonation. While the momentum is almost inversely proportional to the detonation depth, the spectral energy density peaks at some detonation depth which depends on the ratio of distance from the radius of the charge. Figures 2; references 23: 20 Russian, 3 Western (1 in Russian translation).

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PROPAGATION OF CREEP WAVES AROUND ROUGH CYLINDRICAL SURFACE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 23, No 2, Mar-Apr 87
(manuscript received 28 Jan 86) pp 324-330

[Article by Yu. Yu. Popov, Institute of Acoustics imeni N. N. Andreyev,
USSR Academy of Sciences]

[Abstract] The fields of acoustic creep waves propagating around a rough cylindrical surface are evaluated in accordance with the theory of perturbations, but by the method of nonlocal boundary condition rather than by the method of successive approximations, assuming a statistically uniform random surface roughness. The diffraction component of the field is included along with the geometrical-optics component. The corresponding Helmholtz equation with an either Dirichlet or Neumann boundary conditions at the surface is solved with the aid of a Sommerfeld-Watson transformation for a soft surface and for a rigid one. Extremely small-scale roughness and extremely large-scale roughness are treated as the two limiting cases. The results are compared with fields of creep waves around a smooth cylindrical surface and, as a special case, is found the field of a creep wave propagated by surface roughness alone. Figures 2; references 14: 6 Russian, 8 Western (2 in Russian translation).

2415/5915
CSO: 1862/153

THEORY OF TRANSIENT THERMAL SELF-FOCUSING OF SOUND BEAMS

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 30 May 86) pp 331-334

[Article by M. Yu. Romanovskiy, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Transient thermal self-focusing of sound beams during their passage through an attenuating medium is analyzed theoretically in terms of the "lens" effect in all liquids, except in molten metals bismuth and tellurium as well as in water, where sound propagates slower through a hotter region than through a colder one. This "lens" effect is described by two equations, a nonhomogeneous parabolic equation for the amplitude of sound waves and an equation of heat conduction with a heat source proportional to that squared amplitude. The geometrical acoustics approximation is applicable in the ultrasonic frequency range as long as the focal length of the nonlinear thermal lens is not larger than the diffractive divergence radius, as has been the case in experiments, considering also that the magnitude of the self-focusing effect is proportional to the fourth power of the acoustic frequency. Since the amplitude of sound waves and the attenuation coefficient are functions of the radial coordinate and the "traveling"-wave coordinate as well as of time, the equations of geometrical acoustics evolve into a system of five equations including one which describes an assumed parabolic radial temperature profile. Solution of this system of equations, after appropriate change of variables, yields the self-focusing distance and the critical self-focusing energy. The theory constructed on this basis not only accurately interprets transient thermal self-focusing of sound beams observed in experiments but also explains transverse fractionation of a sound beam and the phenomenon of moving foci. References 8: all Russian.

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NONLINEAR AND DIFFRACTION EFFECTS IN SOUND BEAMS WITH RANDOM TRANSVERSE STRUCTURE

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 4 Jun 86) pp 335-341

[Article by O. V. Rudenko and V. A. Khokhlova, Department of Physics, Moscow State University imeni M. V. Lomonosov]

[Abstract] Nonlinear and diffraction effects in transversely random sound beams are described jointly, considering that nonlinear changes in the spectral composition of such sound beams influence the frequency dependence of the diffraction parameters and that presence of a "transverse diffusion" component

in the spectrum causes different interaction than in the case of a plane noise wave. The description is based on the Khokhlova-Zabolotskaya equation for an intense sound beam. With an appropriate change of variables, this equation yields a nonlinear transverse correlation function for a constant noise field which departs from a Gaussian one at the entrance to a nonlinear medium as the sound beam propagates through that medium. While an exact expression for that correlation function has been obtained in the case of plane Riemann waves, it includes the error integral in the general case. Here the problem of diffraction in a nonlinear medium is subsequently solved for a quasi-monochromatic sound beam with a random transverse structure and with that Gaussian field distribution as boundary condition at the entrance to the medium. In this case the correlation function can be linearized and a nonlinear Fourier transform is obtained relating it to the noise spectrum in any cross-section of the sound beam. Further analysis indicates that nonlinear interaction, resulting in generation of harmonics which diffract just as the fundamental wave component, is most effective within the paraxial region and causes additional broadening of the sound beam with a corresponding decrease of the intensity. The correlation radius is found to decrease as the radius of the random sound beam increases, which is analogous to an experimentally observed characteristic of semicoherent light beams propagating through absorbing media and particularly cubically nonlinear ones. The difference lies in the fact that in nonlinear acoustic absorbing media the nonlinearity is predominantly quadratic and dispersion is almost completely absent. The authors thank A. S. Chirkin for helpful discussion. Figures 3; references 14: all Russian.

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UDC 534.833

EFFECTIVENESS OF GRANULAR VIBRATION-ABSORBING BED

Moscow AKUSTICHESKIY ZHURNAL in Russian Vol 33, No 2, Mar-Apr 87
(manuscript received 16 Jan 86) pp 342-347

[Article by V. B. Stepanov, B. D. Tarmakovskiy, and N. Yu. Fedina, Institute of Acoustics imeni N. N. Andreyev, USSR Academy of Sciences]

[Abstract] Absorption of vibrations by a bed consisting of dry sand and metal shot around a horizontal beam subject to flexural vibrations is evaluated theoretically, taking into account amplitude-dependent and thus nonuniform attenuation of waves in such a beam. The attenuation coefficient, which characterizes the effectiveness of such a bed, is calculated from the equation of beam deflection in which it appears under an integral as a function of the longitudinal coordinate with the origin at one beam end. Into account is taken energy transfer from beam to bed by waves breaking away from the beam and local balance of vibration energy within a finite beam segment. The analytical solution is extended numerically, for comparison with the results of an experiment using 1.8 m long steel bars 1 cm thick and 8 mm wide embedded in a mixture of

fine dry sand and lead shot. The grains of lead shot were 6 mm in diameter. The bed, consisting of 1.5 cm and 3 mm thick sand layers and a 6 cm thick shot layer, was confined laterally between rigid boards. Measurements and calculations reveal that accelerations higher than acceleration of gravity low-frequency and medium-frequency vibrations are attenuated principally by break-away and downfall of bed particles, while high-frequency vibrations are most effectively attenuated at accelerations lower than acceleration of gravity and principally by friction. Figures 5; references 5: 4 Russian, 1 Western.

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UDC 778.38

CALCULATION OF NOISE IN SPATIAL SPECKLE-FIELD HOLOGRAMS UNDER CONDITIONS OF SATURATED PHOTORESPONSE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 3, Mar 87
(manuscript received 24 Mar 86, after completion 19 Jul 86) pp 460-465

[Article by V. V. Shkunov and T. V. Yakovleva, Institute of Problems in Mechanics, USSR Academy of Sciences, Moscow]

[Abstract] Intramodulation noise in spatial speckle-field phase holograms recorded in photoresponse-saturating media is calculated according to the speckle theory and taking into account the nonlinear exposure dependence of the photoresponse. Two parameters are introduced, to facilitate calculation of that noise and also of the diffraction efficiency, namely the linear hologram strength equivalent to that in a nonsaturating medium with the same sensitivity and a dimensionless saturation factor equal to the inverse of the phase shift in a thick photographic layer at the maximum possible photoresponse. Calculations reveal that maximum diffraction efficiency requires a minimum saturation factor and that 100% diffraction efficiency will be reached with less than 10 rad deep optically induced phase modulation of the readout wave. Non-linearity of the photoresponse also causes amplitude distortions of the object wave locally reconstructed by the cross-lattice. In both transmission and reflection holograms photoresponse saturation lowers or raises the noise level depending on whether the ratio of object-wave intensity to reference-wave intensity is respectively smaller or larger than 1:2, a larger than 1:2 ratio of these intensities requiring a larger exposure. The authors thank B. Ya. Zeldovich for valuable discussions. Figures 2; references 23: 20 Russian, 3 Western.

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CSO: 1862/160

MIRRORS FOR HIGH-POWER CONTINUOUS-WAVE Ar-LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 3, Mar 87
(manuscript received 23 Jan 86) pp 564-573

[Article by N. D. Goldina, V. I. Donin, G. N. Nikolayev, and T. T. Timofeyev, Institute of Automation and Electrometry, Siberian Department, USSR Academy of Sciences, Novosibirsk]

[Abstract] The performance of various thin-film mirror coatings for a high-power continuous-wave ArII-laser ($\lambda = 465\text{-}515$ nm wavelengths) is evaluated on the basis of an experimental study and theoretical analysis, a 500 W laser typically requiring mirrors which can withstand loads of $5\text{-}10$ kW/cm². Multi-layer coatings of metal oxides with alternately high refractive index n_H (TiO_2 , ZrO_2 , Nb_2O_5 , Ta_2O_5) and low refractive index n_L , each layer of quarter-wavelength thickness ($\lambda_0 = 500$ nm), were deposited on 10 mm thick quartz substrates S according to the scheme $S(\text{LH})^N \text{A}'$ (N - number of n_L -layer and n_H -layer pairs, A' - air) by the cathode sputtering process. For comparison ZnS/MgF_2 mirror coatings were also tested that were produced by thermal resistive sputtering and $\text{ZrO}_2/\text{SiO}_2$ mirror coatings produced by electron-beam vaporization. The scattering indicatrix was plotted over a half-sphere. The integral scattering coefficients and the absorption coefficient were measured, also the heating over 4-15 min transient periods as well as the breakdown threshold. In the analytical part of this evaluation the absorption coefficient is determined from the theoretical temperature transient and from the solution to the corresponding boundary-value problem for the equation of heat conduction, this problem having been solved by the method of finite integral transformations. On the basis of the results, which indicate that mirror coatings produced by cathode sputtering have the best performance characteristics, thermal focusing of high-power laser output radiation is evaluated next with thermal distortions and lens effects in a coating taken into account. While for ArII-laser radiation the scattering coefficient and the absorption coefficient of mirrors produced by cathode sputtering and of mirrors produced by electron-beam vaporization are comparable, 0.04-0.1% and 0.02-0.03% respectively, the breakdown threshold under a focused ArII-laser beam is highest for mirrors produced by electron-beam vaporization, twice as high as for mirrors produced by cathode sputtering and 20 times higher than for mirrors produced by thermal resistive sputtering. Figures 4; tables 1; references 19: 12 Russian, 7 Western.

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UDC 535.373.2

ACCOUNTING FOR KNOCKOUT OF ACCEPTORS DURING TRANSFER ELECTRON-EXCITATION
ENERGY IN DISORDERED MEDIA

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 25 Jul 86) pp 565-570

[Article by A. G. Avanesov, V. F. Pisarenko, and Ye. N. Tumayev]

[Abstract] Disordered solid materials with donor and acceptor impurity-center subsystems are considered, kinetics equations being derived for populations of the respective electron states. These equations are derived for a chemically "averaged" homogeneous crystal containing M donors and N acceptors per unit volume, respectively m and n of them excited at any instant of time t in either of four possible states $(m+1, n)/(m, n+1)/(m+1, n-1)/(m, n)$ with corresponding probabilities of transitions from one state to another within a small time interval Δt . The equations take into account, accordingly, knockout of acceptors during energy transfer so that the transfer of electron excitation in a material with long-lived acceptors is found to depend on the excitation level. The results are sufficiently general to apply not only to knockout of acceptors but also to nonlinear acceptor-acceptor or donor-donor interactions and those depend on the population of the respective subsystem. References 15: 9 Russian, 6 Western (1 in Russian translation).

2415/5915
CSO: 1862/151

UDC 537.35

DIFFUSE SCATTERING OF X-RAYS BY DEFECTS IN Ge:Li SINGLE CRYSTALS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 28, No 12, Dec 86
(manuscript received 22 May 86) pp 3734-3736

[Article by V. V. Ratnikov, L. M. Sorokin, and G. N. Mosina, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] An experimental study of Li-doped Ge single crystals was made, to determine the feasibility of separately measuring diffuse and coherent scattering of x-rays by defects formed upon breakup of the solid solution. Some

crystals had been doped during growth by the Czochralski method, others had been doped by diffusion from the surface at a temperature of 400°C. Measurements were made by the method of differential x-ray diffraction, implementable in a three-crystal spectrometer with a $\text{CuK}_{\alpha 1}$ -radiation source, in the Bragg geometry with appropriate rotation of both analyzer and specimen. The data have yielded $H = 220$ intensity isoline contours in certain section through a reciprocal-lattice node. The results indicate a transformation of the defective structure in broken up Ge-Li solid solution upon supplementary heating at 400°C, x-rays being diffusely scattered by spherical interstitial clusters as well as by interstitial dislocation loops. Figures 2; references 6: 4 Russian, 2 Western.

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CSO: 1862/145

UDC 539.32

ELASTICITY CHARACTERISTICS OF GaSb SINGLE CRYSTAL UNDER PRESSURE UP TO 6.4 GPa

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 28, No 12, Dec 86
(manuscript received 4 Jun 86) pp 3664-3669

[Article by V. A. Goncharova, Ye. V. Chernysheva, and F. F. Voronov, Institute of High-Pressure Physics, USSR Academy of Sciences, Troitsk (Moscow Oblast)]

[Abstract] An experimental study of GaSb single crystals was made, for the purpose of determining the pressure dependence of their elasticity characteristics at room temperature. Tests were performed over the 0-2.5 GPa range in a "Piezometric" high-pressure chamber and over the 2.5-8.2 GPa range in a "toroidal" high-pressure chamber with aircraft-grade gasoline as working medium. Transformation of the first kind, from semiconductor to metallic phase, with attendant sudden dilatation and subsequent fracture was found to begin at a pressure of 6.4 ± 0.4 GPa. Debyeograms recorded after high-pressure tests revealed a sphalerite structure, indicating reversibility of this transformation. The transit time for longitudinal and transverse ultrasonic waves in a GaSb crystal was measured by the pulse-phase method at frequencies of 7.5-10 MHz. Specimens were found to retain their geometrical dimensions within approximately 1 μm under pressure, according to Laue x-ray diffractograms. The experimental data, with a scatter not wider than 0.5-1%, have been normalized to standard length $L_0 = 1$ cm and atmospheric pressure for polynomial fitting by the method of least squares. Further processing has yielded the pressure dependence of the velocity $v_{1[110][100]}$ of longitudinal elastic waves and of the velocities $v_{2[110][001]}$, $v_{3[110][110]}$ of transverse elastic waves, also the pressure dependence of the effective elasticity constants c_{11} , $1/2(c_{11}-c_{12})$, c_{44} . A theoretical evaluation of the data has yielded the pressure dependence of microscale Gruneisen parameters. The results of this study indicate that the Murnaghan pressure-volume equation fits the GaSb semiconductor phase and

that heteropolar GaSb becomes more covalent under rising pressure up to approximately 3 GPa only, while the model of stiff hybridized orbitals applies here only at pressures above 3 GPa. The author thanks V. K. Luykh for assistance in conducting the experiment and Yu. Ya. Boguslavskiy for discussion of the results. Figures 3; tables 2; references 16: 4 Russian, 12 Western (1 in Russian translation).

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CSO: 1862/145

UDC 621.315.592

X-RAY AND ELECTRICAL STUDIES OF PHASE TRANSITION IN $\text{Pb}_{1-x}\text{Ge}_x\text{Se}$

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 28, No 12, Dec 86
(manuscript received 30 Apr 86) pp 3610-3615

[Article by V. F. Kozlovskiy, A. I. Lebedev, and Yu. Ye. Petrov, Moscow State University imeni M. V. Lomonosov]

[Abstract] An experimental study of $\text{Pb}_{1-x}\text{Ge}_x\text{Se}$ ($x = 0.02-0.08$) single crystals was made in search of a ferroelectric phase transition already known to occur in $\text{Pb}_{1-x}\text{Ge}_x\text{Te}$ single crystals with noncentral Ge atoms also existing in either Ge^{2+} or Ge^{4+} ionic states. Electrical and x-ray diffraction measurements were performed on specimens of n-type crystals grown by the sublimation method, with an electron concentration $n \approx 2 \cdot 10^{19} \text{ cm}^{-3}$. The lattice parameter of monophase powders was, after annealing at a temperature of 620°C , measured accurately within $\pm 0.0003 \text{ \AA}$ in a DRON-2 x-ray diffractometer with a CoK_α radiation source, in a DRON-1 x-ray diffractometer at low temperatures. The lattice parameter was found to depend nonlinearly on the crystal composition, $a(\text{\AA}) = 0.1253 - 0.327x - 0.51x^2$ at 20°C room temperature. Electrical measurements yielded the temperature dependence of the electrical resistivity, the otherwise monotonic increase of the latter with rising temperature being disrupted by a hump peaking at a temperature consistently higher for crystals with a higher Ge content. This anomaly is attributable to anomalous scattering of charge carriers due to phase transition. The results generally confirm an analogy to $\text{Pb}_{1-x}\text{Ge}_x\text{Te}$ crystals, except that the critical transition temperature tends to become lower as Se replaces Te and generally a lighter chalcogen atom replaces a heavier one. The low-temperature increase of the electrical resistivity of crystals with a low Ge content is explained by an analog of the Kondo effect. The authors thank V. P. Zlomanov for support. Figures 4; references 17: 10 Russian, 7 Western.

2415/5915
CSO: 1862/145

EQUILIBRIUM OF NORMAL-METAL REGION IN COMPOSITE SUPERCONDUCTORS WITH ARBITRARY ELECTRICAL JUNCTION RESISTANCE

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 2, Feb 87
(manuscript received 21 Nov 85, in final version 14 Jul 86) pp 219-225

[Article by A. A. Akhmetov, All-Union Scientific Research Institute of Metrological Services, Moscow]

[Abstract] Existence of a normal-metal region in composite superconductors is analyzed, assuming a function layer of finite thickness between normal metal and superconductor with zero thermal resistance and arbitrary but small electrical resistance uniform over the boundary. Calculations based on circuit theory yield the normal-metal expansion current and its dependence on the junction resistance. They also yield the conditions for existence of a resistive domain, considering that a normal metal can be only at an unstable equilibrium with the surrounding superconductor. An analysis of the results reveals a threshold junction resistance above which a normal-metal region induced by a heat pulse will expand either by a splitting of resistive domains or in the form of a propagating wave, depending on whether the transport current is respectively not larger or larger than the minimum expansion current. The author thanks V. A. Altov and R. G. Mints for helpful discussion of the results, also V. B. Zenkevich for attentiveness. Figures 5; references 14: 9 Russian, 5 Western.

2415/5915
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USE OF THREE-CRYSTAL TOPOGRAPHY FOR DETECTION AND EXAMINATION OF STRUCTURAL DEFECTS IN CRYSTALS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 2, Feb 87
(manuscript received 20 Dec 85) pp 345-348

[Article by I. A. Nikolskiy, P. V. Petrashen, and M. A. Chernov]

[Abstract] The feasibility of using three-crystal topography for detection and examination of structural microdefects in single crystals of compounds such as A^3B^5 , SiC, $Bi_{12}GeO_{20}$ is demonstrated, conventional two-crystal topography requiring an asymmetric monochromator with zero dispersion and thus being adequate for Si and Ge single crystals only. In the proposed scheme one can use a dispersive asymmetric monochromator, inasmuch as the probing radiation is additionally monochromatized by the second crystal after it has been reflected by the first crystal facing the monochromator. The effects of dispersion in a two-crystal scheme, namely worsening of the resolution and doubling of images, are explained with the aid of duMond diagrams. Such a diagram

is also used for explaining the effectiveness of the three-crystal scheme with the second crystal in a symmetric position relative to the probed third crystal. This scheme was tried successfully for Bragg x-ray spectroscopy of $\text{Bi}_{12}\text{GeO}_{20}$ and SiC single crystals in a DRON-UM1 diffractometer with a BSV-21 x-ray tube and a $\text{CuK}_{\alpha 1}$ -radiation source, using a vibration-proof GUR-8 goniometer. Figures 6; references 4: 2 Russian, 2 Western.

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UDC 548-162:339.16.04

DEPENDENCE OF RADIATIVE DEFECTIVENESS BUILDUP IN ALKALI-HALIDE CRYSTALS ON CURRENT DENSITY OF PULSED ELECTRON BEAM

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 3, Mar 87
(manuscript received 4 Jun 86, after final editing 8 Oct 86) pp 925-928

[Article by Yu. M. Annenkov, T. S. Frangulyan, V. Yu. Yakovlev, V. F. Stolyarenko, and Yu. I. Galanov, Tomsk Polytechnic Institute imeni S. M. Kirov]

[Abstract] An experimental study of ionic crystals was made for the purpose of determining the effect of their excitation by a pulsed high-intensity electron beam, depending on its current density, on the buildup of radiative defects in their lattice. Specimens of KCl and KBr crystals at a temperature of 300 K were bombarded with a 300 keV electron beam in pulses of 18 ns duration at a repetition rate of 0.1 Hz, its current density being varied over the 20-400 A/cm^2 range. For comparison, crystals were also bombarded with low-intensity x-rays in a 50 kV - 20 mA tube with a Mo-anode. The results reveal that, while the concentration of F-centers intensity of impinging radiation, an increase of the electron-beam current density tends to attenuate this buildup. The yield of stable radiative lattice defects accordingly becomes maximum at some critical dose of absorbed radiation power. An analysis based on the current dependence of energy loss and other available data indicates that one limiting factor in buildup of defects, as the electron-beam current density increases, is the less likely survival of thermally stable F-center/ X_3^- -center pairs, probably owing to recombination of these centers by the tunneling mechanism facilitated by their spatial proximity. Figures 2; references 8: 2 Russian, 6 Western.

2415/5915
CSO: 1862/159

ACOUSTIC ANOMALIES IN $\text{Pb}_5\text{Ge}_3\text{O}_{11}$ IN EXTERNAL ELECTRIC FIELD

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 3, Mar 87
(manuscript received 30 Apr 86, after final editing 4 Oct 86) pp 918-921

[Article by G. G. Lomakin and V. Ya. Shur, Ural State University imeni
A. M. Gorkiy, Sverdlovsk]

[Abstract] An experimental study of acoustic anomalies in ferroelectric hexagonal $\text{Pb}_5\text{Ge}_3\text{O}_{11}$ was made under conditions favorable to formation of various domain structures during phase transition. Specimens of $\text{Pb}_5\text{Ge}_3\text{O}_{11}$ single crystals with a 1.0 cm long $Z(C_3)$ -dimension and 0.8 cm^2 large XY-faces had these faces covered by Ag-electrodes. After the specimens had been soaked in paraffin for 30 min with an alternating electric field of $2 \cdot 10^5 \text{ V/m}$ amplitude applied for the purpose of dissipating the space charge pinned on traps, the velocity v_z and the attenuation coefficient α_z of longitudinal 15 MHz acoustic waves propagating parallel to the polar axis were measured: v_z by the pulse-phase method accurately within $5 \cdot 10^{-4}$ and α_z accurately within 5-10% by fitting an exponential calibration curve on echo signal peaks. These measurements were made in an external electric field parallel to the C_3 -axis, its intensity varied over the $0-10^5 \text{ V/m}$ range, while the specimens were cooled from a temperature above 457 K to a temperature below 446 K at a rate of 0.1 K with the temperature field in a specimen maintained uniform with 0.3 K. The results reveal three distinct temperature ranges. At temperatures above 457 K, the para-phase range, the acoustic velocity does not depend on the electric field. Within the 457-446 K phase-transformation temperature range the acoustic velocity is strongly temperature-dependent with a dip to a minimum as well as strongly field-dependent. At temperatures below 446 K, the ferroelectric-phase range, the acoustic velocity increases with increasing electric field intensity and depends on the domain structure which has been formed in a weak field. Correspondingly, the magnitude of the dip of acoustic velocity within the 446-457 K temperature range also decreases with increasing electric field intensity. The acoustic attenuation coefficient peaks within the 457-446 K temperature range, this peak becoming lower with increasing electric field intensity. The acoustic attenuation coefficient also does not depend on the electric field intensity at temperatures above 457 K but decreases with increasing electric field intensity at temperatures below 446 K. These anomalies can be caused not only by formation of a polydomain structure and by quasi-one-dimensional thermal fluctuations of polarization but also by formation of a heterophase structure during transition, owing to a relative high electrical conductivity and presence of defects. The data indicate a tendency of spontaneous polarization into a spatially nonuniform pattern within the phase-transformation temperature range along with the abatement of acoustic anomaly by a constant external electric field. Figures 2; references 18: 16 Russian, 2 Western.

2415/5,15
CSO: 1862/159

ABSORPTION OF ULTRASOUND BY LiIO_3 AT LOW TEMPERATURES

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 293, No 4, Apr 87
(manuscript received 7 Feb 86) pp 834-835

[Article by A. A. Abramovich, A. I. Nedbay, F. Salakhitdinov, and V. A. Shutilov (deceased), Scientific Research Institute of Physics, Leningrad State University imeni A. A. Zhdanov]

[Abstract] An experimental study of hexagonal $\alpha\text{-LiIO}_3$ at low temperatures was made, this piezoceramic semiconductor exhibiting the anomalous electroacoustic echo at low temperatures and a strong acoustoionic effect characterized by a high ionic conductivity in the direction of the hexagonal axis at high temperatures. The temperature-dependent absorption of piezoactive and nonpiezoactive 12-600 MHz ultrasonic waves by pure intrinsic crystals was measured over the 50-270 K temperature range, using the echo pulse method for the 12-100 MHz frequency range and the Bragg diffraction method for the 60-600 MHz frequency range. The specimens had a volume of approximately 2 cm^3 and the shape of a rectangular parallelepiped with faces perpendicular to the crystallographic axes. A piezoceramic plate of the same $\alpha\text{-LiIO}_3$ material was used as a wideband source of ultrasonic waves. The results reveal an absorption peak which is small at 150 K for 12 MHz longitudinal waves and becomes larger while shifting to higher temperatures as the frequency of ultrasonic waves increases. No such anomaly is found in the case of longitudinal waves propagating normally to the hexagonal axis. The energy of absorption activation can be calculated from these data on the basis of the relaxation theory, relaxation in this case being associated with lattice distortion in the vicinity of natural crystal defects. Article was presented by Academician Yu. V. Gulyayev on 24 January 1986. Figures 1; references 5: all Russian.

2415/5915

CSO: 1862/155

OPTICAL BISTABILITY IN SEMICONDUCTORS WITH IMPLANTED IONS

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 6,
26 Mar 87 (manuscript received 16 Jun 86, final edition received 17 Oct 86)
pp 337-340

[Article by V. A. Stadnik and I. Sh. Khasanov, Institute of Solid-State Physics, USSR Academy of Sciences]

[Abstract] An experimental study of optical absorption bistability in semiconductors with implanted ions was made, for the purpose of determining the effect of ion implantation on this bistability. The experiment was performed with ZnSe and an Ar-laser, considering that the edge of the fundamental

absorption band for ZnSe lies at an energy level (2.68 eV) above those of the Ar emission lines 476.5 nm (2.602 eV) and 488.0 nm (2.541 eV). Specimens of ZnSe single crystals were grown from the melt by the Bridgman method. Specimens of polycrystalline ZnSe were produced by chemical deposition from the gaseous phase and then mechanically polished. Specimens of both kinds, their thickness varied over the 0.3-2 mm range, were bombarded on one side with 60-180 keV oxygen or argon ions in doses of $3 \cdot 10^{13}$ - 10^{16} cm⁻². During subsequent irradiation of specimens by an LG-69 or ILA-120 continuous-wave Ar-laser, measurements were made to determine the dependence of the power of transmitted radiation on the power of incident radiation. Slightly oblique rather than normal incidence ensured elimination of interference effects such as refractive feedback. A hysteresis appeared here only after implantation with a dose of 10^{14} ions/cm², but the loop narrowed with further increasing implantation dose till it vanished again after implantation with doses of $3 \cdot 10^{15}$ ions/cm⁻² and larger ones. This absorption bistability was also not found to depend significantly on the kind and the energy of implanted ions. The absorption coefficient is evidently nonlinear within a domain of ZnSe bordering on disordered ones which form during ion implantation by the thermal mechanism of local heating at room temperature, at least 200°C known to be required for switching from upper state to lower state along the hysteresis loop. Figures 2; references 4: 1 Russian, 3 Western.

2415/5915

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UDC 621.373.826.038.825.4

SEMICONDUCTOR LASER WITH ELECTRON-BEAM PUMPING AND FIBER-OPTIC OUTPUT WAVEGUIDE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 28 Nov 85) pp 94-99

[Article by I. G. Goncharov and A. A. Kirillovich, Moscow Institute of Engineering Physics]

[Abstract] An experimental study of semiconductor lasers with transverse electron-beam pumping was made, for the purpose of evaluating injection of their luminous output energy into multimode fiber-optic waveguides. Three types of laser structure were tested: I) homogeneous p-GaAs crystal doped with $2 \cdot 10^{18}$ cm⁻³ Zn, II) active p-GaAs layer doped with $2 \cdot 10^{18}$ cm⁻³ Si grown on passive n-Ga_{0.7}Al_{0.3}As layer inside waveguide cavity, III) triple-layer heterostructure consisting of a thin active p-GaAs layer doped with $8 \cdot 10^{17}$ cm⁻³ Si between two wideband n and p Ga_{0.65}Al_{0.35}As layers. Pumping was done with a 0.5 mm wide beam of 18-24 keV electrons in pulses of 100 ns duration at a repetition rate of 50 Hz. The threshold current density for exciting lasers I, II, III with a beam of 24 keV electrons at a temperature of 85 K was

respectively 5, 0.5, and 0.1 A/cm². Laser I operated in the superluminescence mode when pumped by electrons with less than 24 keV energy. The fiber-optic waveguides, with a numerical aperture of 0.2, consisted of a quartz core 50 μm in diameter and a polymer sheath. Such a waveguide was coupled to a laser in a nitrogen cryostat, with the entrance end of a fiber 15-20 μm away from the face of a laser crystal. Power measurements made behind the resonator exit mirror with an ELU-FK calibrated photoreceiver and a movable diaphragmed photomultiplier have yielded the dependence of the laser output power and the laser-fiber coupling efficiency on the pumping electron energy for each type of laser structure, also the power-current characteristic of these lasers with or without feedback through an external mirror 1 mm away from the face of the laser crystal. Spectrochromograms of the laser output radiation as well as the laser radiation patterns in the near-field region and in the far-field region were recorded, the latter with a FER-2 photoelectronic device. The results indicate that an external mirror improves the output characteristics of a laser with transverse electron beam pumping and inside a waveguide cavity, for most effective direct coupling to a fiber-optic waveguide. The authors thank M. V. Zverkov and V. I. Borodulin for supplying specimens of semiconductor waveguide structures. Figures 6; tables 1; references 9: 6 Russian, 3 Western (1 in Russian translation).

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CSO: 1862/158

UDC 536.7

THERMOCHEMICAL PROPERTIES OF NIOBIUM PENTACHLORIDE IN 8-315 K INTERVAL

Moscow ZHURNAL FIZICHESKOY KHIMII in Russian Vol 60, No 5, May 87
(manuscript received 22 Jul 86) pp 1397-1398

[Article by G. A. Berezovskiy, L. M. Bazhanova, I. Ye. Paukov and V. I. Tsirelnikov, Institute of Inorganic Chemistry, Siberian Division, USSR Academy of Sciences, Novosibirsk and Moscow State Pedagogical Institute imeni V. I. Lenin]

[Abstract] Discovery of interesting applications of metallic niobium necessitated in-depth studies of thermodynamic properties of its chlorides; in this paper thermochemical properties were reported in the temperature range from 8 to 315 K. Heat capacity of niobium pentachloride was reported for 100 experimental points (range 7.98 to 313.45 K). On the basis of these experimental data, the values of entropy, enthalpy and Gibbs energy were calculated. References: 2 Russian.

7813/5915
CSO: 1862/202

ANALYSIS OF SHIFT OF TWO-PHONON POLES IN DEFORMED NUCLEI BY BOSON EXPANSION METHOD

Moscow TEORETICHESKAYA I MATEMATICHESKAYA FIZIKA in Russian Vol 70, No 1, Jan 87

[Article by R. V. Dzholos, S. P. Ivanova, R. Pedrosa, and V. G. Solovyev]

[Abstract] New experimental data indicating an absence of low-energy two-phonon quadrupole states in ^{168}Eu , just as an absence of two-phonon octupole states in several Ra, Th, U isotopes has been noted earlier, is interpreted on the basis of a mathematical model modifying the quasi-particle phonon model for even-even deformed nuclei, considering that those data are inconsistent with the model of interacting bosons. The boson expansion method is used for transforming the Hamiltonian of the quasi-particle phonon model, in accordance with Pauli's exclusion principle, and then calculating the shift of two-phonon poles. The results confirms an absence of collective two-phonon states in such nuclei. References 20: 8 Russian, 12 Western.

2415/5915
CSO: 1862/135

UDC 535.2:621.372.8:535

PARAMETRIC INTERACTION OF OPTICAL MODES IN FIBER-OPTIC LIGHT GUIDE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 12 Sep 86) pp 674-677

[Article by V. L. Stirzhevskiy, V. A. Fonmaniy, and Yu. N. Yashkir]

[Abstract] Parametric interaction of optical modes in an arbitrary fiber-optic structure with quadratically nonlinear susceptibility is analyzed, assuming propagation of natural modes along the fiber axis and a known transverse field distribution. Generation of a sum-frequency wave ($\omega_3 = \omega_1 + \omega_2$) by interaction of a pump wave (frequency ω_1) and an infrared signal wave (frequency ω_2) is considered, for specificity, assuming that the amplitudes of all three fields vary slowly as functions of the longitudinal coordinate. The corresponding system of integro-differential equations is solved for TEM-modes, in standard shorthand notation, with the mathematical apparatus of Bessel and Hankel functions. The solution yields the overlap integral and the Umov-Poynting vector. On this basis is calculated the dependence of the conversion efficiency on the fiber radius and on the half-width of the Gaussian pump-power distribution over modes in a fiber of given radius, this half-width being normalized to the number of the highest-order mode still propagating at the pump wavelength and being proportional to the angular width of the laser beam at the fiber entrance. Figures 2; references 4: 2 Russian, 1 East German, 1 Western.

2415/5915
CSO: 1862/151

COLOR SHADOW METHODS OF ANALYZING RECONSTRUCTED WAVE FRONT

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 4 Apr 86) pp 659-663

[Article by I. S. Zeylikovich, A. M. Lyalikov, and N. M. Spornik]

[Abstract] Two-color shadow holography is proposed, gradients of the refractive index of the phase object being visualized in two mutually perpendicular directions with the use of a Foucault knife-edge diaphragm. Gas lasers are most suitable as the two light sources with sufficiently narrow spectra, typically a He-Ne laser ($\lambda_1 = 632.8$ nm wavelength) and a He-Cd laser ($\lambda_2 = 441.6$ nm wavelength). The two beams, each scattered by a rotating screen and then passed through a converging lens, a slit, and a collimating lens, enter a splitting cube at right angles and leave it to illuminate the hologram. The latter is followed by a lens which focuses transmitted light onto two mutually perpendicular Foucault knife edges preceded by a filter. Two filters are used: one in diffraction order -1 transmits light λ_1 and absorbs light λ_2 , one in diffraction order $+1$ transmits light λ_2 and absorbs light λ_1 . Color shadow patterns are quantitatively processed not with a source of white light producing one such pattern but with tunable quasi-monochromatic light producing monochromatic shadow patterns at various wavelengths of the reconstructing light. As light source is used a KIM 24-150 lamp with a converging lens which passes light to a monochromator. The latter consists of a dispersing Abbe prism between an entrance diaphragm followed by a collimating lens and an exit diaphragm preceded by a converging lens. The spectrum of the light source is scanned by rotating the Abbe prism, the exit diaphragm then extracting a narrow band of light which passes through a collimating lens and a Dove prism before it illuminates the hologram. Behind the hologram is placed a lens which focuses diffraction orders in the plane of the visualizing slit, the latter being oriented parallel to the image of the monochromator exit slit while another collimating lens coordinates the plane of the hologram with the plane of shadow pattern recording. This method is validated theoretically by appropriate calculation and has been demonstrated experimentally by visualization of regions with equal gradients of the refractive index. Figures 3; references 6: 5 Russian, 1 Western.

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OPTICAL FOURIER TRANSFORMATION BY LENSLESS METHOD WITH PERFORATED MASK AND WITH MODIFIED TALBOT INTERFEROMETER FOR ANALYSIS OF INTERFEROGRAMS

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 14 Jul 86) pp 636-643

[Article by A. P. Smirnov]

[Abstract] A method of performing optical Fourier transformation is proposed which involves two Talbot effects, namely by multiplication of the spectra of the Fourier object in the Fresnel diffraction region of a periodically dotted two-dimensional screen and by phase modulation of the field in the Fresnel image consisting of diffraction patterns localized between self-reproduction planes. The two advantages of this method over shift methods of interferometry are that it applies to wider class of objects, since the interference pattern must remain sufficiently sharp, and it provides means of measuring the signal amplitude. The phenomenon of lensless multiplicative Fourier transformation can be demonstrated experimentally not only when the object-transparency with unknown transmission amplitude-phase function lies in the plane of the perforated screen (A. Kolodziejczyk, ACTA OPTICA Vol 28, No 6, 1985 pp 741-746) but also when it lies anywhere between the screen plane and the observation plane, the latter being selected with many degrees of freedom. The phenomenon of phase modulation has also been demonstrated experimentally (A. Kalestynski and B. Smolinska, ACTA OPTICA Vol 28, No 6, 1976 pp 473-479; T. D. Ebralidze, R. Sh. Megredishvili, and M. A. Bazadze OPTIKA I SPEKTROSKOPIYA Vol 58, No 1, 1985 pp 197-199). For analysis by an appropriately modified Talbot interferometer, the source is illuminated with a plane coherent wave of unity amplitude. Analysis of the interferometer according to the theory of linear systems and the Talbot theory reveals a finite spectrum of the object field and a Fourier spectrum with a scale factor which varies as the location of the object between the two planes is varied. The modulation coefficients of Fresnel images are evaluated by the matrix method of linear algebra, with the weight factors in the general case linearly independent by virtue of the symmetry property of the phase matrix and with not only linearly independent sets of weight factors but also linear combinations thereof. For calculating the phase of the object spectrum is then derived a system of algebraic equations reducible to a multiple sum in cyclically permutable coefficients, the multiplicity of the sum depending on the number of sets of weight factors and thus on the number of readings. Figures 3; references 22: 8 Russian, 14 Western (5 in Russian translation).

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KINETICS AND SPECTRUM OF LIGHT PULSE USED IN PICOSECOND HOLOGRAPHY

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 20 Feb 86) pp 631-635

[Article by R. F. Malikov and R. Kh. Mustafin]

[Abstract] Picosecond holography in spectrally selective media with special nonuniform contour is analyzed for the dependence of the form and the spectrum of the output signal on the form and the transverse relaxation of the incident probing pulse. Application of the theory of coherent light pulse amplification based on the Maxwell-Block equation, assuming linear amplification in a medium with large nonuniform broadening and then assuming negligible changes in population inversion, reveals that the spectrum of the output signal duplicates the hologram on a nonuniform contour while transverse relaxation suppresses modulation in the Fourier spectrum and thus causes fading of the hologram. The equation is first solved analytically, after linearization, and then numerically for a YAG:Nd³⁺ crystal as spectrally selective medium with either a small area ($\theta < 1$) or a large area ($\theta \sim 1$) of the incident field and thus with correspondingly linear or nonlinear amplification. The results indicate that linear amplification and an incident field with a spectrum at least as wide as the large nonuniform contour will ensure retention and erasure of holograms in such an absorbing medium. Figures 5; references 14: 9 Russian, 5 Western (1 in Russian translation).

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LIGHT ATTENUATION MATRICES FOR SEVERAL ALLOTROPES OF ICE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 22 May 86) pp 604-609

[Article by V. V. Bogorodskiy and Ye. S. Volodin]

[Abstract] Light attenuation matrices are evaluated for the equation of radiation transfer which describes propagation of light through and interaction with single crystals and several known polycrystalline allotropes of ice, including the polarization effect for better accuracy, ice being a turbid medium with the lowest refractive index of all known minerals. The 4-dimensional square Mueller matrix multiplied by the Stokes vector of light entering ice yields the Stokes vector of light leaving ice, this product being calculated for various orientations of the incident light beam relative to the freezing plane, for four different polarizations of incident light (45° and 90°, dextrorotatory and levorotatory), and for six different states of the medium.

The results of calculations with appropriate numerical values of all matrix elements, including calculations for synthetically grown hexagonal ice crystal, are compared with stereograms. Figures 1; references 3: all Russian.

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INFRARED $S_n + S_1$ ABSORPTION IN RETINYL ACETATE AND IN RETINAL ALDIMINE

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 25 Jul 86) pp 532-537

[Article by S. M. Bachilo and S. L. Bondarev]

[Abstract] Optical transition between lower states ${}^1\bar{B}_u$ and ${}^1\bar{A}_g$ as well as to higher excited electronic states in retinyl acetate and in retinal aldimine was studied by the method of nanosecond laser photolysis, with direct recording of radiation absorption by molecules in excited singlet state. For the study were used 6-s-cis, holotransretinyl acetate and 6-s-cis, holotrans-n-butylaminic retinal Schiff base with appropriately purified and dried solvents. Films of polyvinyl butyral and mixture of diethyl ether + petroleinic ether + isopropyl alcohol in 5:5:2 ratio were activated with 10^{-3} mol/dm³ retinoid in ethanol solution for spectrometry at room temperature and at 77 K respectively. They were excited with second-harmonic radiation from a ruby laser in pulses of 20-25 ns duration and 20-60 mJ energy. They were probed with a light beam from an ISSh 100-6 flash lamp parallel to the exciting laser beam. Recording and measuring apparatus included FD-10 GA photodiodes, and FK-19 photocell, two oscillographs S8-12, S8-13 and two V4-17 pulse voltmeter for intensity of absorbed light and of transmitted light one of each as well as for intensity of exciting radiation, also a monochromator with 100-250 cm⁻¹ resolution within the 1.0-1.65 μ m range of wavelengths. Absorption spectra and fluorescence spectra reveal $S_n + S_1$ absorption in both retinoid compounds. The long-wave absorption band of retinyl acetate has a maximum at the $\lambda = 1.55 \mu$ m wavelength at room temperature and is evidently attributable to $S_2 + S_1$ transition. The shift of maximum absorption in both retinyl acetate and retinal aldimine at 77 K, to $\lambda = 1.15 \mu$ m and to $\lambda = 1.22 \mu$ m respectively, is probably attributable to $S_n + S_1$ transition. These conclusions are supported by theoretical determination of the relevant extinction coefficients, then the oscillator strength and the dipole moments of transitions, the results of calculations indicating high degrees of fluorescence polarization and absorption dichroism. The authors thank B. I. Mitsner and Ye. N. Karnaukhova for supplying retinal aldimine. Figures 3; tables 1; references 21: 9 Russian, 12 Western.

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SCATTERING OF OPTICAL RADIATION BY BURSTING WATER PARTICLES IN FOG

Tomsk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: FIZIKA in Russian Vol 30, No 2, Feb 87 (manuscript received 29 Mar 85, after completion 11 Jun 85) pp 79-84

[Article by V. I. Kokhanov, M. F. Nebolsin, and L. K. Chistyakova, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences]

[Abstract] An experimental study of optically thin fog interacting with radiation pulses from a CO_2 -laser was made, with the aid of probing radiation from a He-Ne laser. Pulses of acting radiation, of microsecond duration and up to 10 J energy with the energy density varied over the 1-50 J/cm² range by means of 60 μm thick 50%-transmission dacron filters, were recorded by an FP-5 photoreceiver indicating their time distribution. Fog with an optical thickness $\tau_{0.63}$ of the order of 10^{-3} was generated by a machine ejecting it in the form of a jet 2.5 mm in diameter with a velocity of 8 m/s and with a $3.3 \cdot 10^4 \text{ cm}^{-3}$ concentration of water drops having a mean-cubic radius of 2.4 μm , perpendicularly to the acting laser beam and completely within the focusing region. The probing laser beam crossed the fog at a 45° angle to the acting one. Its scattering by water drops in the fog was recorded by an FEU-38 photomultiplier using optics with a 1° field of vision. The results of this probing reveal the dynamics of channel formation in a fog by passing laser radiation which causes bursting of water drops. The data yield the characteristic times of turbidization and transillumination as well as the dimensions of the explosion products and their degree of vaporization during the "tail" of an acting radiation pulse, all depending on its energy density. They also reveal appreciable scattering of visible radiation from a probing He-Ne laser by shock waves, but only during the initial period of gas-dynamic bursting not longer than the characteristic time equal to the diameter of the laser beam divided by the speed of sound. Figures 2; tables 2; references 11: 9 Russian, 2 Western (1 in Russian translation).

2415/5915

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SPECTRAL CHARACTERISTICS OF XeCl EXCIMER IN 300-311 nm WAVEBAND

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 27 Nov 85) pp 80-86

[Article by V. A. Adamovich, V. Yu. Baranov, A. A. Deryugin, I. V. Kochetov, D. D. Malyuta, A. P. Napartovich, Yu. B. Smakovskiy and A. P. Streltsov, Institute of Atomic Energy imeni I. V. Kurchatov, Moscow]

[Abstract] An experimental study of the XeCl excimer molecule was made for a determination of its spontaneous luminescence in the 300-311 nm waveband under pressures of 0.132-3.4 atm. A CCl_4 -Xe-Ar mixture with the optimum ratio $\text{CCl}_4:\text{Xe}:\text{Ar} = 1:20:1500$ was excited by means of an electron beam from a high-current accelerator, with a $4 \times 30 \text{ mm}^2$ cross-section and an approximately 150 A/cm^2 current density in pulses of approximately 350 keV energy and approximately 25 ns duration. The spectrum of spontaneous luminescence of an XeCl molecule was recorded on a KN-4S film having a gamma of 0.61 with the aid of an STE-1 spectrograph. The spectrograms were calibrated against the spectrum of iron in an electric arc. Induced amplification under high pressure was abated by shortening the active length of the medium to 7 cm. A comparison of the data with calculated gain and dispersion coefficient reveal the spectral characteristics of a $B \rightarrow X$ transition and particularly of a $B(v'=0) \rightarrow X(v''=0,1,2,\dots)$ transition in the 307-309 nm waveband, also the divergence of an XeCl laser. The calculations are based on Franck-Condon factors, which depend on the vibrational numbers v', v'' of upper and lower electron terms respectively as well as on the rotational number J , also using the Franck-Condon density. The results indicate that the phase gradient, a function of the wavelength, is most largely influenced by indeterminacy of the dependence of the Franck-Condon factors on the rotational number J . The authors thank M. R. Aliyev, Yu. Yu. Stepanov, and Yu. Z. Ionikh for helpful discussion of the results. Figures 5; tables 2; references 19: 6 Russian, 13 Western (1 in Russian translation).

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HOLOGRAPHIC SELECTOR TELESCOPE WITH SLIDING DIFFRACTION

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 3, Mar 87
(manuscript received 3 Feb 86) pp 597-602

[Article by M. V. Vasnetsov, I. G. Sokolova, M. S. Soskin, and V. B. Taranenko,
Institute of Physics, UkSSR Academy of Sciences, Kiev]

[Abstract] A holographic telescope with a grating which operates under sliding incidence and diffraction angles is proposed, to serve as selector of radiation emitted by tunable dye lasers. A design and performance analysis of such a selector telescope with a spatial phase grating recorded in a gelatine layer on a light-injecting glass substrate yields the angular selectivity patterns depending on the depth of refractive-index modulation. Bichromated gelatin is eminently suitable for holographic recording of spatial phase gratings with high diffraction efficiency and minimum scattering, up to 5000 lines/mm, this material being also characterized by a high optical strength of $2\text{--}4 \text{ J/cm}^2$ under giant nanosecond light pulses. Recording in this medium is a two-stage process, exposure of sensitized chromate salts to blue-green light from a He-Cd laser or an Ar^+ -laser followed by developing in water and fixing in isopropyl alcohol. Results of experiments indicate that reducing the Fresnel reflection losses at the grating-air boundary and homogenization of the gelatine layer can increase the diffraction efficiency to approximately 30% at an incidence angle of 88° . Figures 5; references 14: 9 Russian, 5 Western.

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UDC 621.373:535(206.2)

RATE CONSTANTS OF MOLECULAR PROCESSES REGULATING LEVEL OF INDUCED ABSORPTION IN OPTICALLY PUMPED DYE LASER ON WATER-MICELLAR SOLUTION OF RHODAMINE 6G

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 2 Sep 86) pp 571-577

[Article by M. B. Levin, M. I. Snegov, and A. S. Cherkasov]

[Abstract] A method is proposed for calculating spectroscopic rate constants which determine concentration of short-lived absorption centers during interconversion and quenching in optically pumped dye lasers, these constants including the lifetime of products responsible for reversible induced absorption. The method is based on comparing threshold intensities in laser cavities with different Q-factors. The method was tested on a laser with $10^{-5} \text{ mol./dm}^3$ rhodamine 6G in water-micellar solution ($2 \cdot 10^{-2} \text{ mol./dm}^3$ sodium dodecyl-sulfate in heavy water) as active medium and with cyclooctatetraene as quencher, in two

different cavities. The experimental data confirm the calculations and indicate that the conversion products are triplet molecules of rhodamine 6G. They are comparable with known data pertaining to rhodamine 6G lasers with other quenchers. Figures 1; references 29: 19 Russian, 10 Western (1 in Russian translation).

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STATISTICS OF BREAKDOWN CENTERS APPEARING DURING PROPAGATION OF LASER RADIATION THROUGH TURBULENT ATMOSPHERE

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 30, No 2, Feb 87 (manuscript received 19 Apr 85) pp 75-79

[Article by M. S. Belenkiy, Yu. D. Kopytin and S. T. Penin, Institute of Atmospheric Optics, Siberian Department, USSR Academy of Sciences]

[Abstract] Focusing of laser radiation propagating through a real atmosphere with background aerosol is considered, taking into account polydispersity of the aerosol and turbulence of the air. While polydispersity of the aerosol determines the concentration statistics of particles larger than the threshold size within the caustic region, turbulence of the air determines the lateral radiation spiking as well as the turbulent beam broadening and thus contributes to a random distribution of the threshold breakdown intensity. Randomization of breakdown centers by both factors is analyzed and their statistical characteristics are evaluated for radiation emitted by a CO_2 -laser in microsecond pulses and propagating through a mildly turbid atmosphere, assuming a chemically homogeneous aerosol with an asymptotic power-law distribution function $f(\alpha) = c_0 \alpha^{-n-1}$ of particles larger than $0.1 \mu\text{m}$ and assuming a negligible thermal laser self-action during thermodynamically slow focusing by a Cassegrain telescope with $R_0/F_0 \gtrsim 10^{-3}$. Numerical results are obtained for typical apertures and coherence radii. Figures 3; tables 1; references 11: 9 Russian, 2 Western.

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MODE LOCKING IN Nd-LASER BY MEANS OF Gd-Sc-Ga-GARNET SHUTTER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 2, Feb 87
(manuscript received 22 May 86) pp 423-424

[Article by M. I. Demchuk, Ye. V. Zharikov, A. M. Zabaznov, I. A. Manichev, V. P. Mikhaylov, A. M. Prokhorov, A. P. Shkadarevich, A. F. Chernyakovskiy, I. A. Shcherbakov and K. V. Yumashev, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] An experiment with passive mode locking in a Nd-laser by means of a GSGG (Gd-Sc-Ga garnet) shutter was performed, such a shutter being placed inside the resonator cavity between a spherical mirror (2.5 m radius of curvature, 0.99 reflection coefficient) and a plane exit mirror (0.7 reflection coefficient). The active medium was a YAG(Nd) rod 65 mm long and 5 mm in diameter. Trains of ultrashort emission pulses were recorded with an FK-20 photocell and on a 6 LOR-04 oscillograph. Pulse energy and duration were measured with an "IMO" 2N instrument and in an "Agat" SF-1 electron-optical spectrophotometer chamber respectively. Crystals of Gd-Sc-Ga garnets were pretested for absorption spectrum and absorption relaxation time. Specimens with a transmission coefficient ranging from 0.2 to 0.65 were used for mode locking. Minimum pulse duration of 80 ps was attained with a 1 cm long shutter having a 0.2 transmission coefficient, pulse durations of 105-120 ps being most probable and shorter duration being more probable than longer ones according to the histogram. The radiation power density at such a shutter was 160 MW/cm^2 under conditions of optimum mode locking. The resonator cavity was redesigned for "100% modulation" Q-switching. With such a resonator, the probability of emission was higher than 90% and pulses of 0.5-1 ns duration appeared with some background noise. Figures 3; references 11: 8 Russian, 3 Western.

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LASER SIMULATION OF LIGHT AND PLASMA ACTION ON COMETS AND PLANETS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 2, Feb 87
(manuscript received 1 Sep 86) pp 229-230

[Article by G. A. Askaryan and I. M. Rayevskiy, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] With the parameters of laser simulation of astrophysical phenomena such as action of ultraviolet light and plasma on comets and planets having been established on the basis of theoretical estimates, a laboratory experiment

was performed for study of surface ablation and photoionization by strong bursts of laser radiation and by plasma jets emanating from irradiated targets. The experiment was performed using a Nd-laser with Q-switching. The laser beam was focused on metal and dielectric targets, with a drop of picene 2 mm in diameter simulating a comet or a planet placed on a thin dish 2 cm away from the target outside the laser beam. The effects of ultraviolet light and of target-material plasma were recorded by high-speed photography as well as with instrumentation including a photomultiplier, parasitic light emitted by the target being blocked by a rectangular mask projecting onto the bright corona of dispersing plasma. They were also measured with electrical back-to-back probes. The results are very promising for use of laser simulation in a wide range of astrophysical research. Figures 3; references 3: all Russian.

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HIGH-POWER PERIODIC-PULSE YAG:Nd³⁺-LASER SYSTEM WITH TELESCOPIC UNSTABLE RESONATOR AND TWO-STAGE AMPLIFIER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 2, Feb 87
(manuscript received 12 Dec 85) pp 265-270

[Article by P. A. Apanasevich, V. V. Kvach, V. G. Koptev, V. A. Orlovich, A. A. Stavrov and A. P. Shkadarevich, Institute of Physics, BSSR Academy of Sciences, Minsk]

[Abstract] A laser system is described which includes a periodic-pulse YAG:Nd³⁺-laser oscillator with a telescopic rather than confocal unstable resonator and two YAG:Nd³⁺-laser amplifier stages. The resonator cavity is formed by two spherical mirrors, a concave one and a convex one. Inside this cavity the active medium facing the concave mirror is followed by a quarter-wavelength plate, a polarizer, a diaphragm, and a Q-switch facing the convex mirror. The active medium, a YAG + 0.88 wt.% Nd rod 6.5 mm in diameter and 65 mm long inside a cylindrical quartz monoblock with Ag-coating 40 mm in diameter and 60 mm long, is pumped by an ISP-2500 flashtube in pulses of up to 50 J energy at a repetition rate of 10 Hz so that a positive thermal lens with a focal length of 9 m will be induced as a result. The Q-switch is either an electro-optic crystal (DKDP) or a passive shutter (LiF crystal with F₂⁻ color centers).

The amplifier consists of two YAG:Nd³⁺-laser stages, the first one with 1.1 wt.% Nd and the second one with 0.8 wt.% Nd, the second stage pumped by two INP-5/75A-1 flashtubes. The apertures of the system components are matched by means of two expanding lens telescopes. The threshold pumping energy for this laser system is 8 J. Following an experimental development, the system has been designed to generate output pulses of up to 1.25 J energy and 12-20 ns duration at a repetition rate of 10 Hz. The authors thank V. P. Kozich, A. S. Grabchikov and A. I. Vodchits for assistance in the experiments and discussion of the results, also V. A. Pismenny for supplying the high-quality YAG:Nd³⁺ rods. Figures 4; references 18: 9 Russian, 9 Western.

2415/5915
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TUNABLE $\text{Al}_2\text{O}_3:\text{Ti}^{3+}$ -LASER WITH OPTICAL PUMPING

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 6,
26 Mar 87 (manuscript received 24 Dec 86) pp 369-371

[Article by Kh. S. Bagdasarov, V. P. Danilov, T. M. Murina, Ye. G. Novikov,
A. M. Prokhorov, V. B. Semenov and Ye. A. Fedorov, Institute of General Physics,
USSR Academy of Sciences, Moscow]

[Abstract] A tunable laser with optical pumping was realized experimentally, using an $\text{Al}_2\text{O}_3:\text{Ti}^{3+}$ crystal and an INPZ-7/80 flash lamp with "Kvant-12" interference coating. The lamp operated with a luminaire and a K75-28 capacitor bank, the latter placed very close to the lamp so as to ensure minimum rise time of optical pumping pulses. With a capacitance of 33 μF were obtained flashes of 30 μs duration with a rise time not exceeding 12 μs . High quality $\text{Al}_2\text{O}_3:\text{Ti}^{3+}$ crystals had been grown by the method of horizontal oriented crystallization. The resonator cavity was formed by a spherical opaque substrate with dielectric coating and a plane exit mirror, three different mirrors being used with 97%, 91%, 83% reflection respectively. With the 83%-reflection mirror and pumping pulses of 140 J energy, the laser crystals emitted pulses of 46 mJ energy. The emission threshold, 30-35 J pumping pulse energy, did not significantly depend on the reflection coefficient of the exit mirror. In such a nonselective cavity the emission band was only 770-810 nm wide, but in a dispersive cavity formed by nearly 100%-reflection mirrors and including a 60°-prism the wavelength of laser emission could be varied continuously over the 690-870 nm range. The results of this study indicate the feasibility of building a widely tunable $\text{Al}_2\text{O}_3:\text{Ti}^{3+}$ -laser with components used for conventional YAG:Nd³⁺-lasers. The authors thank V. A. Alekseyev and A. V. Shulenin for assistance. Figures 2; references 4: 2 Russian, 2 Western.

2415/5915
CSO: 1862/157

VISIBLE InGaAsP/GaAsP LASERS PRODUCED BY EPITAXIAL GROWTH FROM LIQUID PHASE

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 6,
26 Mar 87 (manuscript received 5 Jan 87) pp 372-374

[Article by Zh. I. Alferov, I. N. Arsenyev, D. Z. Garbuzov, N. A. Strugov,
A. V. Tikunov and Ye. I. Chudinova, Institute of Engineering Physics imeni
A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] Continuous-wave injection lasers emitting radiation at a wavelength as short as 0.653-0.671 μm within the visible range at a temperature of 300 K have been realized with InGaAsP/GaAsP dual heterojunctions produced by epitaxial growth from the liquid phase. The structure of these devices consisted of a GaAs/GaAsP substrate with about 40% P in the upper part of the

GaAsF layer, $\text{In}_{0.3}\text{Ga}_{0.7}\text{P}$ emitter layers, $\text{In}_{0.2}\text{Ga}_{0.8}\text{As}_{0.21}\text{P}_{0.79}$ waveguide layers, and a narrow-band active region. As active region were used InGaAsP solid solutions with various In:Ga:As:P ratios and with the same lattice period as that of the substrate. The threshold current density for five of such lasers varied from 0.76 to 4.0 kA/cm² as the energy gap of the active region was widened. In a 500 μm long resonator cavity a 12 μm wide strip of such a laser emitted a power up to and even above 3 MW at an excitation current of 250-300 mA. The authors thank M. K. Trukan and T. N. Drokin for assistance in assembly of laser diodes. Figures 1; tables 1; references 3: 2 Russian, 1 Western.

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UDC 621.373.826.038.824

DYE LASERS PUMPED BY RADIATION FROM HIGH-POWER SEMICONDUCTOR LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 5 May 86) pp 218-219

[Article by O. V. Bogdankevich, M. M. Zverev, Ye. M. Krasavina, I. V. Kryukova and V. F. Pevtsov, All-Union Scientific Research Center for Studying Properties of Surfaces and Vacuum]

[Abstract] An experimental study of two dye lasers was made, with pumping by radiation from semiconductor lasers at higher than heretofore power levels. The rhodamine-6G laser was pumped with a CdS laser and the latter by a 350 keV electron beam at a current density of 100-150 A/cm² in pulses of 25 ns duration. Maximum efficiency above 50% was attained with a dye concentration of 50 $\mu\text{mol./l}$, between two mirrors with reflection coefficients $R_1 = 0.15$ and $R_2 = 1.0$ respectively, maximum emission pulse energy of 52 mJ was attained at a 50% efficiency. The dye-K47 laser ($\lambda = 460$ nm wavelength) was pumped with a ZnO laser ($\lambda = 397$ nm wavelength) and the latter was pumped just as the CdS laser, an emission pulse energy of 3 mJ having been attained here at a 10% efficiency. Pumping energy and emission energy were measured with a KP-100 calorimeter, pumping and emission pulses were recorded with an FK-15 photocell and an S1-9 oscillograph, and spectra of emitted radiation were recorded in a DFS-24 spectrometer. Figures 2; references 3: all Russian.

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CONTINUOUSLY FREQUENCY-TUNABLE HIGH-PRESSURE CO₂ LASER WITH PLASMATIC CATHODE

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 24 Apr 86) pp 216-218

[Article by N. V. Karlov, A. V. Kisletsov, I. Kovalev, G. P. Kuzmin, A. A. Nesterenko and E. M. Khokhlov, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] A compact 1 MW CO₂-laser operating with a CO₂:N₂ = 1:1 mixture under a pressure of 8 atm was built and tested, the plasma of a discharge sliding over the surface of a dielectric serving both as source of ultraviolet preionization and as cathode. Such a cathode facilitates stabilization of a high-current space charge. The discharge slides over the surface of a 1.7 mm thick pyroceramic plate, covering an area of 20x250 mm², inside a hermetic chamber formed by a glass-plastic tube with a 10 mm thick NaCl Brewster plate at each end. The distance from cathode to metal anode is 6 mm, the active volume is 12 cm³, and the energy input to the mixture required for building an electric field of 20 kV/(cm·atm) intensity and generating current pulses of 50 ns maximum duration is 150 J/1·atm. An outstanding feature of this laser is that its frequency is continuously tunable and can be perfectly locked by means of a calibrated IKS-21 monochromator and a BaF₂ beam splitter within four bands: 938-951 cm⁻¹, 970-980 cm⁻¹, 1041-1054 cm⁻¹, 1073-1083 cm⁻¹ corresponding respectively to P and R branches of 00⁰1-10⁰0 and 00⁰1-02⁰0 transitions. The frequency tuning was monitored with a Fabry-Perot interferometer on a 9.8 mm air base and the frequency dependence of the laser emission energy was determined on the basis of measurements with pyroelectric photoreceivers. The authors thank A. M. Prokhorov for attentiveness. Figures 3; references 11: 8 Russian, 3 Western.

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EFFICIENCY OF IONIC NOBLE GAS AND ALKALI METAL MOLECULES AS ULTRAVIOLET AND FAR-ULTRAVIOLET LASERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 10 Feb 86) pp 185-187

[Article by N. G. Basov, M. G. Voytik, V. S. Zuyev, A. D. Klementov, V. P. Kutakhov and S. A. Pendyur, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] Heteronuclear ionic molecules, specifically noble gas and alkali metal molecules, have been proposed as lasers. The efficiency of such lasers is demonstrated here on molecules forming and dissociating in Xe-Cs mixtures.

capable of lasing at the $\lambda = 170$ nm wavelength upon excitation by an electron beam. Processes $\text{Xe}^+ + \text{Cs} + \text{Xe} \rightarrow \text{Xe}^+\text{Cs} + \text{Xe}$ and $\text{Xe}_2^+ + \text{Cs} \rightarrow \text{Xe}^+\text{Cs} + \text{Xe}$ populate the Xe^+Cs upper laser level, both contributing comparably according to their respective rate constants but the second process producing most of the molecules in analogy to the "harpoon" reaction of alkali metals and halogens. At the lower laser level is a XeCs^+ molecule, largely dissociated at temperatures of 300-400°C, and this level does not depopulate as a result of electron-ion recombination owing to a very low rate constant of that process. A possible depopulation channel is the $\text{XeCs}^+ + \text{Cs} \rightarrow \text{Cs}_2^+ + \text{Xe}$ process. Radiation emission in pulses of 100 ns or 10 ns duration at an efficiency of approximately 5% should be attainable with an electron-beam pumping power density of 100 kW/cm³ or 1 MW/cm³ and an Xe pressure of 1-2 atm or 3-5 atm, respectively, in Xe:Cs = 10,000:3-1000:1 mixtures. Figures 1; tables 1; references 3: 2 Russian, 1 Western (in Russian translation).

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FEASIBILITY OF CHEMICAL LASERS BASED ON CHAIN REACTION INVOLVING HYDROGEN FLUORINATION WITH THERMAL BRANCHING MECHANISM

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 5 Nov 85) pp 151-157

[Article by E. U. Baykov, A. S. Bashkin and A. N. Orayevskiy, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] A new possibility of realizing pulsed $\text{H}_2\text{-F}_2$ lasers by thermal dissociation of molecules of appropriate fluorine compounds RF is proposed, namely the heretofore not considered mechanism of thermal branching in the chain reaction by injection of additional such molecules into the original $\text{H}_2\text{-F}_2$ mixture. The success of this method hinges on selection of the additional fluorine compound RF whose molecules dissociate at a sufficiently high rate as the temperature of the mixture rises. Analytical solution of the corresponding equations of thermodynamics for the given chemical reactions and numerical evaluation of the dissociation rate constant for required laser performance and emission pulse characteristics, supported by experimental data, indicate that the necessary conditions are attainable with $\text{H}_2:\text{F}_2:\text{O}_2:\text{RF}$ mixtures with an RF molecule such as F_2SO_3 whose rate constant of $\text{F}_2\text{SO}_3 \rightarrow \text{F} + \text{FSO}_3$ dissociation is $k_{\text{oo}} = 10^{15.13} e^{-33(\text{kcal/mol})/RT} \text{ s}^{-1}$. Figures 3; references 12: all Russian.

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HIGH-EFFICIENCY GaAs SEMICONDUCTOR LASER WITH LONGITUDINAL EXCITATION BY SCANNING ELECTRON BEAM

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 12 Nov 85) pp 170-176

[Article by A. A. Gubarev, V. I. Kozlovskiy, B. M. Lavrushin, A. S. Nasibov and P. V. Reznikov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] An experimental study of two GaAs semiconductor lasers with longitudinal excitation by a scanning electron beam was made for finding ways to attain a high efficiency. Two ingots of GaAs were grown by the Czochralski method and subsequently doped. The smaller ingot, 30 mm in diameter, was doped with Te to an electron concentration $n = 1.5 \cdot 10^{18} \text{ cm}^{-3}$ with an electron mobility $u = 3200 \text{ cm}^2/(\text{V} \cdot \text{s})$ at a temperature of 300 K. The larger ingot, 60 mm in diameter, was doped with Sn to an electron concentration $n = 0.19 \cdot 10^{18} \text{ cm}^{-3}$ with an electron mobility $u = 3500 \text{ cm}^2/(\text{V} \cdot \text{s})$ at a temperature of 300 K. The laser elements were constructed unconventionally, with an Ag coating as 97%-reflection opaque first mirror and a stack of nine quarter-wave alternate ZnS and Na_3AlF_6 layers as 93+1%-reflection exit mirror, using the chemical-mechanical polishing technology with use of SiO_2 sol as abrasive and organic acids as chemically active component. These laser elements were pumped by a 50 keV or 75 keV electron beam forming a spot 10-15 μm on the surface and scanning the latter at a rate of 1.6 mm/ μs . Tests were performed at two temperatures, 80 K and 300 K, with the pumping power calculated and the laser emission power measured by an FK-19 vacuum photocell having an absolute sensitivity of $2.60 \pm 0.38 \text{ mA/W}$ at the $\lambda = 830 \text{ nm}$ wavelength and $2.40 \pm 0.35 \text{ mA/W}$ at the $\lambda = 890 \text{ nm}$ wavelength. An evaluation of the data, supported by a theoretical analysis of processes and mechanisms, indicates the possibility of attaining a high laser efficiency of $24 \pm 5\%$ at 80 K and $7.1 \pm 1.5\%$ at 300 K with the passive region of the resonator cavity cleared of interband absorption. The authors thank G. Ye. Libo for advising on chemical-mechanical polishing. A. A. Yegorov and I. V. Akimov for successfully applying this technology to GaAs laser elements, and Yu. N. Popov for measuring their surface roughness, also Yu. M. Popov and R. F. Nabiyeu for helpful discussions of the results. Figures 1; tables 1; references 17: 11 Russian, 6 Western (1 in Russian translation).

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CHARACTERISTICS OF AMPLIFICATION OF PICOSECOND ULTRAVIOLET PULSES IN XeCl-AMPLIFIER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 19 Nov 85) pp 62-66

[Article by V. T. Platonenko and V. D. Taranukhin, Moscow State University
imeni M. V. Lomonosov]

[Abstract] Amplification of picosecond ultraviolet pulses in a XeCl-amplifier is evaluated first analytically and then numerically. Specifically amplification at the most intense $B(v = 0) \rightarrow X(v = 2)$ electron-vibrational transition in a XeCl molecule is considered, taking into account the possibility of coherent effects and the real energy structure of such a molecule. The calculations are based on a system of equations which includes otherwise nonresonant elements of the density matrix. A double peaking pulse spectrum is obtained in the case of large gain and consequently saturated linear filtration, since the "long-wave" part of a picosecond pulse is more effectively amplified than its "short-wave" part. The resulting evolution of the pulse spectrum indicates that it is possible to further shorten the duration of ultrashort pulses in the process of their amplification. Figures 3; references 7: 4 Russian, 3 Western.

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PERIODIC-PULSE SEMICONDUCTOR LASER WITH ELECTRON-BEAM PUMPING

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 3, Mar 87
(manuscript received 5 May 86, in final form 24 Sep 86) pp 605-607

[Article by O. V. Bogdankevich, M. M. Zverev, S. P. Kopyt, Ye. M. Krasavina,
I. V. Kryukova, L. G. Novozhilova and V. F. Pevtsov, All-Union Scientific
Research Center for Studying Properties of Surfaces and Vacuum]

[Abstract] Four semiconductor lasers emitting pulses of 8 ns duration at a repetition rate of 50 Hz were built and tested, with electron-beam pumping but without forced cooling of the active elements on sapphire heat sinks at room temperature. These lasers are a 140 μm thick ZnO crystal ($\lambda = 394.6$ nm wavelength, $P = 25$ mW average power) with a 66%-reflection exit mirror and a 130 A/cm^2 threshold current density, a 220 μm thick ZnSe crystal ($\lambda = 477.5$ nm wavelength, $P = 22$ mW average power) with a 40%-reflection exit mirror and a 70 A/cm^2 threshold current density, a 350 μm thick CdS crystal ($\lambda = 526.4$ nm wavelength, $P = 125$ mW average power with a 70%-reflection exit mirror and a 135 A/cm^2 threshold current density, and a 150 μm thick GaAs crystal ($P = 90$ mW average power) with a 51%-reflection exit mirror and a 60 A/cm^2 threshold

current density. The lasers are pumped by a 200 keV electron beam 1 cm in diameter, in pulses of 10 ns duration and 0.5 J energy, coming from a small electron gun with field-emission cathode and 150 μ m thick Be foil diaphragm operating with a MIRA-4D generator of x-ray pulses. Emission pulses were recorded with an FK-30 coaxial photocell and an S7-15 high-speed oscillograph, radiation spectra were recorded in a RGS-2" spectrograph with a $4 \cdot 10^{-2}$ nm resolution. The performance characteristics of these lasers are even better in the monopulse emission mode. The authors thank Ye. V. Matveyenko, T. Yu. Ivanova, and V. A. Ushakhin for making some of the measurements. Figures 3; tables 1; references 3: all Russian.

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ACTIVE SYNTHESIS OF APERTURE DURING OBSERVATION OF OBJECTS THROUGH
DISTORTING MEDIUM

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 3 Feb 86) pp 187-189

[Article by N. D. Ustinov, A. V. Anufriyev, A. L. Volpov, Yu. A. Zimin and
A. I. Tolmachev]

[Abstract] Reconstructing images of an object by illuminating it with coherent light space-mosulated on its surface is proposed, such an active aperture synthesis requiring only measurement of the total power of scattered radiation without the necessity to record images. The validity of this method is demonstrated by geometrical analysis of the synthesis process for the case of a phase-distorting medium between a small object and the telescope as well as by estimates of amplitude and phase fidelity of a thus reconstructed space spectrum. References 7: 2 Russian, 5 Western (3 in Russian translation).

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SPONTANEOUS MAGNETIC FIELDS IN LASER PLASMA RECORDED AT 'DELFIN-1' FACILITY

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 4, 25 Feb 87 (manuscript received 13 Jan 87) pp 173-176

[Article by N. G. Basov, Ye. G. Gamaliy, A. A. Rupasov, G. S. Sarkisov, G. V. Sklizkov, V. T. Tikhonchuk and A. S. Shikanov, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, E. Wolowski, S. Denus and T. Pisarczyk, Institute of Plasma Physics and Laser Microfusion imeni S. Kaliski, Warsaw, Poland]

[Abstract] Spontaneous magnetic fields in a laser plasma were recorded, for the first time, at the Delfin-1 facility. Radiation from a Nd-laser was focused on targets, an array of six beams consisting of 18 pencils each with a total energy of approximately 1 kJ and a power density of approximately $8 \cdot 10^{13}$ W/cm² impinging in pulses of approximately 5 ns duration on spherical glass shells 400-600 μ m in diameter with a 1-3 μ m wall thickness. The magnetic fields were measured with second-harmonic and third-harmonic probing laser beams by the method of Faraday rotation of their polarization plane. The diagnostic apparatus included a shadow-graphical recording channel as well as a polarimetric one and an interferometric one. With this instrumentation were obtained the radial profile of the Faraday rotation angle over the cross-section of the probing laser beam and the path of an electromagnetic wave passing through the spherical plasma corona with a magnetic field generated by the thermal-e.m.f. mechanism. Interpretation of the data on the basis of theoretical analysis and calculations indicates that not only the Faraday effect but also the Cotton-Mouton effect operates here, both effects contributing comparably to rotation of the polarization plane of a probing laser beam. Figures 2; references 4: 2 Russian, 2 Western.

2415/5915
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CHARACTERISTICS OF ION BEAMS FROM PLASMA ACCELERATOR

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 30, No 2, Feb 87 (manuscript received 3 Oct 85) pp 20-24

[Article by V. G. Nazarov, A. M. Vinogradov, A. N. Veselovzorov, and V. K. Yefremov, All-Union Correspondence Institute of Machine Design and Institute of Atomic Energy imeni I. V. Kurchatov]

[Abstract] An experimental study of a plasma accelerator with closed electron drift as an ion source was made, for the purpose of determining the dependence of the ion-beam current density, energy, and divergence angle on the accelerator operating parameters. The experimental apparatus included a gas feed system, a gas distributor acting also as anode, a compensator acting also as cathode, an insulator with the acceleration channel, a wound magnet, an electric probe, a multigrid analyzer probe, a milliammeter, and an XY-potentiometer. The ion source operated with argon as plasma generating gas, without forced cooling of the magnetizing coil. The three principal operating parameters of the ion source were: gas feed rate Q_{Ar} , anode-to-cathode accelerating discharge voltage V_a , and magnetizing current I_m . Preliminary tests have established the operating ranges of these parameters as well as a quantitative relation for the discharge current, namely $I_d = 5.68Q_{Ar} - 13.5V_a^{-0.5}$, which indicates the possibility of stabilizing the ion source with respect to the gas feed rate by monitoring the more easily measurable discharge current. Subsequent measurements have yielded the dependence of the ion-beam parameters, including their longitudinal and radial profiles, on the ion-source parameters. The relations are describable by simple analytical expressions. Figures 4; references 4: all Russian.

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CSO: 1862/150

UDC 534.232.082.73

NONLINEAR EVOLUTION OF STRONG ACOUSTIC PLASMA PULSE

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 3, Mar 87
(manuscript received 22 May 86, after final editing 4 Sep 86) pp 763-771

[Article by V. Ya. Demizhovskiy and V. Ye. Sautkin, Gorkiy Research Institute of Engineering Physics, State University imeni N. I. Lobachevskiy, Gorkiy]

[Abstract] Nonlinear evolution of acoustic plasma pulses in solids such as bismuth or other semimetals is evaluated both analytically and numerically. First is calculated the concentration distribution of resonant particles and then, with their concentration as a function of the potential energy and the

latter a function of the Riemann coordinate in the pulse field, is solved the Poisson equation describing pulse evolution in a conductor with a quadratically anisotropic spectrum. The results reveal that in pure conductors pulse attenuation becomes nonlinear at small amplitudes. Pulse attenuation in semimetals is found to be determined principally by resonant heavy particles, holes, and has an amplitude threshold. Figures 4; references 3: 2 Russian, 1 Western.

2415/5915

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PHENOMENOLOGICAL MODEL OF SUPERCONDUCTIVITY OF HEAVY FERMIONS IN $U_{1-x}Th_xBe_{13}$
 Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI
 in Russian Vol 45, No 4, 25 Feb 87 (manuscript received 11 Nov 86) pp 181-184

[Article by V. V. Moshchalkov, Moscow State University imeni M. V. Lomonosov]

[Abstract] Superconductivity of the nonmagnetic compounds UBe_{13} with heavy fermions and "impure" $U_{1-x}Th_xBe_{13}$ ones is examined, their superconductivity being attributable to the heavy fermions characterized by a large ratio of transition temperature T_c to Fermi energy E_F . Interaction of superconductivity and coherence in the Kondo lattice is described by a model Hamiltonian which includes giantly anomalous peaking of the specific heat as well as superconductivity fluctuations near that temperature. Analysis of the phenomenon takes into account the magnetic moment induced at temperatures $T < T_{c2}$ and "stretching" of the interval between transitions. The results of calculations on this basis suggest that the peak of sound absorption at 0.82 K in UBe_{13} ($T_c = 0.86$ K) is associated with strong fluctuations in the vicinity of the sound transition at $T = T_{c2} \sim T_c$, that the negative proximity effect is associated with amplification of fluctuations at $T \rightarrow T_c$ and the giant derivative $dH_{c2}/dT = 200-500$ kOe/K is associated with low sensitivity of fluctuational superconductivity to a weak magnetic field. They also suggest that in the coherent state at temperatures $T < T_{c2}$ substitution of Th for U gives rise to an induced magnetic moment and increases the interaction parameters. They reveal a pressure dependence of the $T_c(x)$ relation for $U_{1-x}Th_xBe_{13}$, including a revertible superconductivity within the $x = 0.02-0.05$ range under pressures above 8 kbar. The "splitting" of $T_c(x)$ and $T_{c2}(x)$ curves is apparently characteristic of Th impurity only, other impurities causing a faster suppression of the $T_c(x)$ dependence before it and the $T_{c2}(x)$ dependence "split". The author thanks A. A. Abrikosov, N. B. Brandt, A. I. Buzdin, E. W. Fenton, and K. Svozil for discussing the results, and N. A. Samarin for assisting in the numerical computations. Figures 2; references 19: 3 Russian, 16 Western.

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 CSO: 1862/152

PROPERTIES OF SUPERCONDUCTING TUNNEL STRUCTURES IN MICROWAVE RADIATION FIELD

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 2, Feb 87
(manuscript received 29 Nov 85) pp 330-335

[Article by F. I. Korzhinskiy, S. A. Koziychuk, A. N. Korolev, V. A. Obolonskiy, A. B. Orlenko, and A. S. Polishchuk, Institute of Cybernetics imeni V. M. Glushkov, UkSSR Academy of Sciences, Kiev]

[Abstract] An experimental study of Nb-NbO₂-Pb superconducting tunnel structures was made, for the purpose of determining the microwave characteristics of such structures produced by an advance technology. Specimens in the form of a film microcircuit consisting of a 4-25 μm^2 large tunnel junction, a low-pass filter, and contact pads on a 0.2 mm thick 1x10 mm² large quartz substrate were produced by electron-beam lithography, purification of the superconductor film with a beam of inert-gas ions, and thermal oxidation in active oxygen. Their current-voltage characteristics were measured in liquid helium at a temperature of 4.2 K, using direct current along up to 30 μA allowing a current density of 10^2 - 10^4 A/cm² as well as with up to 40 nW microwave power at 75 GHz or 100 GHz frequency added. The experimental data, with correction for the leakage current on the basis of the noise equivalent power, reveal two soft steps along the current-voltage characteristics near the gap voltage separated by an $\Delta f/e$ interval equal to 0.3 mV at 75 GHz and 0.41 mV at 100 GHz. Close reproducibility of the results and close agreement with design calculations indicate the feasibility of microcircuit miniaturization to submicron size by application of electron-beam lithography. The authors thank V. A. Kulikov for assistance in performance of experiments. Figures 4; references 9: 3 Russian, 6 Western.

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PRESSURE DEPENDENCE OF SUPERCONDUCTING TRANSITION TEMPERATURE FOR β -PHASE
BIS-(ETHYLENEDITHIOLO)TETRATHIOFULVALENE IODIDE β -(ET)₂I₃ UP TO
 $T_c = 7.5$ K LIMIT

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 3, Mar 87
(manuscript received 29 Jul 86, after final editing 9 Oct 86) pp 931-934

[Article by P. A. Kononovich, V. N. Laukhin, Yu. V. Sushko and I. F. Shchegolev, Institute of Physical Chemistry, USSR Academy of Sciences, Chernogolovka (Moscow Oblast) Department]

[Abstract] Crystals of the metallic β -(ET)₂I₃ phase of bis-(ethylenedithiolo) tetrathiofulvalene iodide were studied for a determination of the pressure dependence of their superconducting transition temperature. The specific

purpose was comparing the α -8 phase, its transition to superconductivity beginning at 8-9 K and ending at 5-6 K, with the β -1.5 phase becoming superconductive at 1.5 K under atmospheric pressure and undergoing modification under higher pressure so that the superconducting transition temperature increases but does not exceed 7.5 K. The electrical resistance was measured with direct current in the α -direction by the voltage-current method, inside a "cylinder and piston" chamber with the pressure set to various levels up to 3.2 kbar at room temperature. Two different specimens of the α -phase were produced by different heat treatment of the dielectric ϵ -(RT)₂I₇ phase, with the center temperature of the superconducting transition range under atmospheric pressure (1 kbar) 5.3 K and 7.5 K respectively. For both specimens the superconducting transition range was found to shift under rising pressure, an indication of existence of this phase in two possible superconducting states: a low-pressure state and a high-pressure state with transition at the same approximately 1 kbar level as for the β -1.5 phase. Noteworthy is the anomalously steep derivative dT_c/dP up to 3 K/kbar for the low-pressure phase relative to 1 K/kbar for the high-pressure phase. Existence of the α -8 phase with $T_c \approx 7.5$ K under atmospheric pressure can be explained by internal stresses in the mosaic crystal structure, by disordering with attendant lowering of the superconducting transition temperature and partial dielectrization of the electronic subsystem, or by twinning of crystals during phase transition, this third possibility having been suggested by M. S. Khaykin and I. N. Khlyustikov. The authors thank E. B. Yagubskiy for interest and helpful comments, also A. I. Kotov and Ye. E. Laukhina for supplying the specimens. Figures 2; references 16: 11 Russian, 5 Western.

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MECHANISM OF CHANGE OF VORTEX STRUCTURE ORIENTATION IN TYPE-II SUPERCONDUCTORS

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 3, Mar 87
(manuscript received 4 Jul 86, after final editing 29 Sep 86) pp 841-845

[Article by V. M. Dzugutov, All-Union Institute of Electrical Engineering imeni V. I. Lenin, Moscow]

[Abstract] Change of the vortex structure configuration in a type-II superconductor following a change of orientation of the external magnetic field is analyzed, considering a magnetic field which consists of two mutually orthogonal components parallel to the plane superconductor surface: a constant one and a harmonically alternating one. According to the empirical Boyer-LeBlanc model, change of orientation is accompanied by appearance of an orientation-angle gradient normal to the superconductor surface. One suggested mechanism is penetration of vortex filaments into the superconductor across a barrier related to surface imperfection, filaments parallel to the magnetic field and

thus changing their orientation with the latter. Experimental data of this study, under conditions where the penetration mechanism can hardly work, indicate an alternative mechanism associated with twisting of the vortex structure. The experiment was performed with a vibration magnetometer measuring the magnetic induction in a specimen while both components of magnetization, the constant one and the alternating one were separately recorded. Two superconductor specimens were tested, one a stack of four 0.05 mm thick Nb₃Sn ribbons with electrolytically polished surface and one a stack of four 0.02 mm thick Nb ribbons cold rolled, all ribbons 10 mm wide and 20 mm long separated by dielectric interlayers in each stack. Theoretical analysis of the results, magnetization curves and changes in the hysteresis loss, and their interpretation in terms of propagation of torsional strain with the orientation-angle gradient reaching a critical magnitude indicate that, while partial penetration of vortex filaments still occurs, here change of the vortex structure orientation is indeed not associated with their penetration. The author thanks L. M. Fisher for discussions and valuable comments. Figures 4; references 14: 4 Russian, 10 Western.

2415/5915
CSO: 1862/159

UDC 541.44

SUPERCONDUCTIVITY AND CRYSTAL STRUCTURE OF HIGH-PRESSURE PHASES IN V-Ru-H SYSTEM

Leningrad FIZIKA TVERDOGO TELA in Russian Vol 29, No 3, Mar 87
(manuscript received 18 Jun 86) pp 665-671

[Article by V. Ye. Animonov, I. T. Belash, Ye. G. Ponyatovskiy, V. I. Rashchupkin, and I. M. Romanenko, Institute of Solid-State Physics, USSR Academy of Sciences, Chernogolovka (Moscow Oblast)]

[Abstract] In the continuing search for materials which, upon hydrogenation, form phase with higher superconductor transition temperature, V-Ru alloys were selected for study on the basis of analogy to already familiar Nb-Ru and Ta-Ru alloys with superconducting transition. Specimens of V-Ru alloys were produced by mixing electrolytic powder of each metal into three batches with 10, 18, 33 atom.% Ru respectively, compacting the mixtures under a pressure of 20 kbar at room temperature, and then sintering them in an induction furnace in an Ar atmosphere. The compacts were annealed at 1200°C under a vacuum of 10⁻⁶ torr for 24 h and then cooled in the furnace. Pieces cut from finished compacts by the electric-spark method, 0.3 mm thick and 3x3 mm² large blanks, were polished twice: once by grinding away a 0.05 mm thick layer and then by electrolytically etching away another 0.03 mm thick layer with H₂SO₄. The specimens of three alloys now containing 10, 18.5, 34±0.4 atom.% Ru respectively, according to chemical analysis in a CAMEBAX-MBX microanalyzer with a Link 860-500 x-ray spectrometer, were hydrogenated in a H₂ atmosphere at a temperature of 300°C under pressures up to 70 kbar for 24 h and then quenched under pressure to a temperature about -180°C. The hydrogen content afterwards was determined,

accurately within 5%, from the amount of H_2 evolving during thermal decomposition at a temperature of $500^\circ C$. Specimens were also examined, at a temperature of 83 K, in a DRON-2.0 x-ray diffractometer with CuK_α -radiation source. The superconducting transition temperature was measured by the inductive method. The results reveal formation of a phase with the atomic hydrogen-to-metal ratio $H:Mo \approx 1$ and an f.c.c. metal sublattice in the $V_{90}Ru_{10}$ -H alloy only, only this phase being superconductive at temperatures $T \geq 2$ K with a 0.3 K wide transition range. The authors thank A. I. Amelin and V. A. Zavyalov for assisting in preparation of experiment, and V. G. Glebovskiy for supplying specimens of V-Ru alloys. Figures 4; references 10: 4 Russian, 6 Western.

2415/5915

CSO: 1862/159

UDC 535.34-15:539.238:546.3

DEPENDENCE OF LOW-TEMPERATURE INFRARED ABSORPTION BY METAL FILMS ON MICRO-CHARACTERISTICS AND SURFACE STATE OF FILM MATERIAL

Leningrad OPTIKA I SPEKTROSKOPIYA in Russian Vol 62, No 3, Mar 87
(manuscript received 14 Jul 86) pp 585-589

[Article by G. A. Dubinina, M. N. Libenson and S. A. Luttsev]

[Abstract] Infrared absorption by metal coating films at low temperatures, typically 4.2 K and 77 K, is described analytically on the basis of anomalous and low-frequency normal skin effects, taking into account electron velocity on the Fermi surface, plasma frequency of electrons, electrical resistivity of film material, and length of mean free path for electrons. Calculations for Al, Cu, Ag, Au films with total or zero mirror reflection of electrons yield numerical data on their optical emissivity which do not agree with corresponding experimental ones on such metal films with mechanically polished, electronically polished, chemically cleaned, or etched surface but indicate the degree of surface defectiveness and yield useful estimates of purity as well as absorption capacity of metal films. Figures 4; tables 1; references 6; all Russian.

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CSO: 1862/151

UDC 681.782.473:681.335

OPTOELECTRONIC INTERFEROMETRIC ANALOG-TO-DIGITAL CONVERTER

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 2, Feb 87
(manuscript received 7 May 86) pp 233-243

[Article by N. N. Yevtikhiyev, S. S. Karinskiy, D. I. Mirovitskiy, and V. T. Popkov, Moscow Institute of Radioelectronics and Automation]

[Abstract] An optoelectronic interferometric 4-digit analog-to-digital converter with a speed of approximately 160 Mbit/s is described, this device consisting of a pulsed laser, an electronic input stage, a Mach-Zender interferometer formed by an integrated-optics modulator array, a photoreceiver array, an electronic amplifier array, and an electronic comparator array. Following a design and performance analysis, the necessary topology of the modulator array of LiNbO_3 :Ti waveguides for this device has been developed on

the basis of calculations by the variational method and manufacturing precision estimates. A prototype interferometric modulator array had been built and tested, before the complete converter was produced for design and performance evaluation. The authors thank Ye. M. Zolotov, P. N. Luskinovich, V. B. Baglikov, Ye. A. Tserbakov, and V. F. Maksimov for helpful discussions. V. Ye. Golubkov, A. I. Zaytsev, I. A. Sidorova, B. V. Sukharev, V. A. Shulgin, V. N. Gunkin, V. M. Busurin, and S. A. Yashina for assistance in building and testing prototype device. Figures 7; tables 1; references 25: 10 Russian, 15 Western.

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CSO: 1862/149

UDC 538.244.2

COMPRESSION OF PLASMA SHELLS BY FROZEN-IN MAGNETIC FIELD

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 2, Feb 87
(manuscript received 2 Jan 86) pp 242-246

[Article by R. B. Baksht, A. L. Velikovich, B. A. Kablambayev, M. A. Liberman, A. V. Luchinskiy and N. A. Ratakhin, Institute of High-Current Electronics, Siberian Department, USSR Academy of Sciences, Tomsk]

[Abstract] Experiments with radial compression of plasma shells formed by jets of ionized vapor emanating from cathode spots in an axial magnetic field have yielded results which indicate the feasibility of producing ultrastrong pulsed magnetic fields. The apparatus consisted of two main electrodes, namely a cathode surrounded by a ring of 40 uniformly spaced igniting electrodes and an anode connected to a 3.5-15 kV capacitor bank, and two coils wound on ferrite cores producing an axial magnetic field almost uniform throughout the linear space inside a vacuum chamber when energized with current pulses of 0.5 kA amplitude and 500 μ s duration. Spots on the cathode surface were produced by application of voltage pulses of 24 kV amplitude and 50 ns duration to the igniting electrode ring. Attendant discharge of the capacitor bank through the interelectrode space within a time of 10 μ s and flow of a 4-10 kA "drawing" current through the cathode spots resulted in formation of plasma jets across the interelectrode gap. The magnetic field contributed to homogeneity of the plasma shell by facilitating a uniform ignition of emission centers within the cathode spots and by preventing thermal expansion of the plasma jets inward. The specific mass of a plasma shell and the voltage rise during collapse under pressure were determined from the erosion of cathode spots and on oscillograms respectively. Evaluation of the data in the zero-dimensional "snowplow" approximation and solution of the one-dimensional ideal-MHD equations with application of similarity laws have yielded the same dependence of the pinch current on the final-state parameter, namely minimum radius of the compressed plasma shell and maximum intensity of the magnetic field. On this basis can be estimated the necessary magnetic field energy and the parameters of compression dynamics. The authors thank Ya. B. Zeldovich and G. A. Mesyats for helpful discussions. Figures 5; references 9: 4 Russian, 5 Western.

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DETECTOR OF ION BEAMS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 2, Feb 87
(manuscript received 7 Jan 86) pp 300-305

[Article by N. N. Aruyov, Ye. L. Baydakov and B. A. Mamyurin, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] A detector of weak ion beams has been developed for use with a magnetic resonance mass-spectrometer. Its basic feature is effective suppression of the background β -electron current generated during decay of tritium nuclei. It consists of an ion-electron converter with a target for ion beams acting also as emitter of secondary electrons, inside a vacuum chamber with a window, a monolithic scintillator behind a diaphragm, and an FEU-92 photomultiplier. The scintillator, a $\text{CaF}_2(\text{Eu})$ screen, has microsecond afterglow time. An up to 10 μm thick photoresist FP-25 coating on the polished scintillator surface protects the latter against direct penetration of tritium atoms and molecules. It also restrains β -electrons covering the entire 0-18.6 keV energy range and passes a large fraction of secondary electrons with energy determined by the potential of the converter emitter. The photoresist coating is covered with a less than 50 μm thick aluminum layer electrically tied to the scintillator housing, its purpose being to act as the anode for secondary electrons and also to increase the efficiency of photon recording. It prevents backscattering of light and transmission of scattered light from the cathode of the ion source to the photomultiplier entrance. The target-emitter of the converter is a sphere 15 mm in diameter with a flat, held at a negative potential smoothly adjustable over the 0-32 kV range. The photomultiplier is cooled by vapor of liquid nitrogen, which reduces the dark current to 50-60 pulses/s and maximizes the signal-to-noise ratio. The detector was tested and its background β -electron current found to be 500-1000 times smaller with a protective photoresist coating than with a protective aluminum coating on the scintillator surface. Figures 2; references 20: 9 Russian, 11 Western.

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DETERMINING HALF-LIFE OF TRITIUM FROM CURVE OF $^3\text{He}/^4\text{He}$ RATIO READINGS

Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 57, No 2, Feb 87
(manuscript received 11 Feb 86, in final version 4 Sep 86) pp 291-294

[Article by Yu. A. Akulov, B. A. Mamyurin, L. V. Khabarin, and V. S. Yudenich, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] A new method of determining the half-life of tritium is proposed which makes an accuracy within 0.5% or better attainable. Its essence is measuring the ratio of helium isotopes $^3\text{He}/^4\text{He}$ in a gaseous mixture of these isotopes with tritiated molecular hydrogen at several successive instants of time and comparing the results with those pertaining to a reference mixture of the two helium isotopes without tritium. Based on theoretical analysis of such a measurement, this method can be implemented with a specimen of gaseous tritiated hydrogen in any of the three possible forms T_2 , HT, DT purified by passage through a hot palladium membrane which removes traces of helium isotopes and other impurities. Controlled mixing with the helium isotopes is done in a vacuum chamber. An accuracy analysis reveals that this method has a much smaller systematic error than the conventional ^3He accumulation method and calorimetric method. Its random error is reduced by use of a two-beam mass-spectrometer for simultaneous measurement of $^3\text{He}^+$ and $^4\text{He}^+$ ion currents. References 12: 4 Russian, 8 Western (1 in Russian translation).

2415/5915
CSO: 1862/148

MOVING IONOSPHERIC PERTURBATIONS INDUCED BY WAVE TRAINS PROPAGATING THROUGH OCEAN

Leningrad PISMA V ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 13, No 6, 26 Mar 87 (manuscript received 18 Nov 86) pp 351-354

[Article by V. I. Pavlov and A. I. Sukhorukov, Institute of Terrestrial Magnetism, Ionosphere, and Radio Waves Propagation]

[Abstract] Perturbations in the lower ionosphere induced by acoustic wave trains propagating through an ocean are analyzed, such perturbations being generated not by sound which travels slower in water than in air but by gravitational waves. The wave profile is assumed to be that of a cosh^{-2} -soliton and edge effects are disregarded. The corresponding system of equations of hydrodynamics for perturbations in an isothermal atmosphere is reduced to a single equation. From its solution for the appropriate boundary conditions, quiescence at the surface and radiation according to the duality principle at

infinity, are calculated perturbations of the electron concentration in the D-layer and in the E-layer, where the influence of terrestrial magnetism is already weak and the quiescent electron concentration is an exponential function of the altitude. In the standard approximation and at altitudes not exceeding 90 km, these perturbations are found to move horizontally parallel to the wave trains in an ocean. Figures 1; references 7: 5 Russian, 2 Western.

2415/5915

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UDC 621.3.029.76:621.373.826:533.9

CHARACTERISTICS OF LASER-PLASMA X-RADIATION SOURCE (REVIEW)

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 1, Jan 87
(manuscript received 24 Dec 85) pp 5-26

[Article by A. V. Vinogradov and V. N. Shlyaptsev, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] Research on the radiation emission characteristics of multiply charged ions in a laser plasma and development of such sources of x-radiation is theoretically based on simulation of plasma and gas dynamic processes along with local coronal and thermodynamic equilibria for a reliable description of the spectrum and calculation of the absolute intensity. The review of the status given here covers first steady-state radiation losses in a multiply ionized homogeneous plasma and transient radiation losses during the plasma ionization process, also characteristics of the ionized state, calculated on the basis of atomic constants and emission rates as well as the special distribution of radiation. Next the review covers conversion of laser radiation into x-radiation based on fundamental equations and a one-dimensional model describing the distribution of plasma microparameters for calculation of the conversion coefficient. The model accounts for a discrete radiation spectrum, unstable ionization, and non-Spitzer heat conduction, but ignores radiation transfer. It is compared with other one-dimensional or two-dimensional models which ignore one or two of these aspects. The validity and the accuracy of all models are analyzed and, with conditions for and ranges of their established, the proposed model is found to be adequate on the basis of available experimental data pertaining to CO₂ and Nd lasers. The authors thank L. A. Vaynshteyn and I. V. Nemchinov for² discussions. Figures 13; tables 2; references 84: 45 Russian, 39 Western (1 in Russian translation).

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COLLIMATION OF SOFT X-RAYS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 3, Mar 87
(manuscript received 13 Jun 86) pp 617-618

[Article by O. B. Ananin, Yu. A. Bykovskiy, A. K. Zverkov and I. Ya. Frondzey,
Moscow Institute of Engineering Physics]

[Abstract] Propagation of soft x-rays from a laser plasma through a long waveguide was studied, such a waveguide being formed by two $77 \times 77 \text{ mm}^2$ large square glass plates parallel within $1 \text{ }\mu\text{m}$ and $200 \text{ }\mu\text{m}$ apart with a $0.3 \text{ }\mu\text{m}$ thick Cr-coating on each inside a vacuum chamber under a residual pressure of 0.1 mm Hg . The approximation of geometrical optics applies here, inasmuch as the $8\text{-}25 \text{ }\text{\AA}$ wavelengths of soft x-rays are much smaller than the waveguide dimensions. Collimation was checked at the exit with thermoluminescent detectors and 45 mm behind the exit on a UF-VR x-ray film under a filter with a $0.3 \text{ }\mu\text{m}$ thick Al-coating, with the source $200 \text{ }\mu\text{m}$ in diameter at a distance of 13 mm before the waveguide entrance. The highest peak of the radiation pattern behind the waveguide exit corresponds to straight propagation and to the first reflection by a Cr-coated glass plate along the way, further peaks corresponding to multiple reflections along the waveguide walls. The radiation pattern and thus the maximum divergence angle of x-rays leaving the waveguide depend not only on the geometry of the experiment, as moving the radiation source and the recording film closer to or farther from the waveguide would reveal, but also on the critical total-internal-reflection angle in the waveguide. Figures 2; references 4: 3 Russian, 1 Western.

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MULTICHANNEL ANISOTROPIC SINGLE-MODE FIBER OPTICS FOR TRANSDUCERS

Moscow KVANTOVAYA ELEKTRONIKA in Russian Vol 14, No 3, Mar 87
(manuscript received 20 May 86) pp 609-611

[Article by A. N. Guryanov, D. D. Gusovskiy, G. G. Devyatykh, Ye. M. Dianov, V. B. Neustruyev and A. M. Prokhorov, Institute of General Physics, USSR Academy of Sciences, Moscow, Institute of Chemistry, USSR Academy of Sciences, Gorkiy]

[Abstract] Multi(2,3,4)channel single-mode fiber optics for transducers were produced by the multirod-in-tube method with two, three, or four $\text{SiO}_2\text{:GeO}_2$ cores inside a common SiO_2 sheath. All cores are identical, which ensures retention of mutual coherence of light along channels even with up to 1000°C hot spots present. Each core has an elliptical cross-section, which is the principal cause of optical asymmetry. Unidirectional orientation of the

birefringence axes facilitates excitation of natural modes without loss of linear polarization in all channels simultaneously. Azimuthal angle dependence of the relative phase shift of mode fields in channels under lateral strain results in a selective sensitivity to direction of strain, which is useful for recording strains on the basis of the shift of interference fringes. These characteristics together with the ability to separate parasitic thermal and vibration effects render such fiber optics eminently suitable for strain and pressure transducers as well as for Doppler velocimeters and hydrophones. Figures 3; references 5: 2 Russian, 3 Western.

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UDC 517.948+531.13

FERMI-ULAM MODEL

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 292, No 3, 1987
(manuscript received 5 Sep 85) pp 545-553

[Article by L. D. Pustyl'nikov, All-Union State Planning, Surveying, and Scientific Research Institute of Power Systems and Electric Power Networks]

[Abstract] Fermi's statistical model of particle acceleration in space containing macrobodies is applied to Ulam's problem of two parallel plates oscillating in the direction normal to them and a ball bouncing back and forth from one to the other after successive elastic impacts on them. The displacement of each oscillating plate is generally a different function of time, but both functions are assumed to be analytic. Two theorems are stated and proved relevant to solving this ball acceleration problem. The first theorem, with a lemma, establishes conditions under which there exists an upper bound for the ball velocity at any instant of time after any impact, assuming that the distance between the two plates is much larger than the oscillation amplitude of each. The second theorem demonstrates that the absolute ball velocity never exceeds a constant limit which depends on the initial velocity of the ball and on the timing of its first impact. Article was presented by Academician A. N. Kolmogorov on 4 September 1985. The author thanks W. I. Arnold, A. I. Neustadt and Ya. G. Sinay for helpful discussions and valuable comments. References 7: 4 Russian, 1 East German, 2 Western.

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MATHEMATICAL PROBLEMS CONCERNING ACTIVE CORPUSCULAR PLASMA DIAGNOSTICS

Moscow VESTNIK MOSKOVSKOGO UNIVERSITETA: VYCHISLITELNAYA MATEMATIKA I KIBERNETIKA in Russian No 3, Jul-Sep 86 (manuscript received 29 Jan 86)
pp 20-26

[Article by Yu. N. Dnesterovskiy, D. P. Kostomarov and A. V. Melnikov]

[Abstract] Corpuscular methods of plasma diagnostics in addition to ranging and tomography are considered, especially for experimental determination of the ionic component and its characteristics. The mathematical part involves solution of inverse problems on the basis of measured energy spectra. While neutral particles play an essential role in passive corpuscular diagnostics, the practical part of active corpuscular diagnostics involves injection hydrogen or deuterium atoms, or injection of heavy atoms or ions such as those of cesium or thallium. Following the description of a tokamak T-10 experiment with injection of Cs^+ ions and with an ion detector-counter, a mathematical model is constructed for determining the electron concentration in the plasma from the results of measurement. The geometry of the experiment is taken into account, including the array of detector lines as well as trajectories of Cs^+ primary and Cs^{++} secondary ions. Assumption of axial symmetry reduces the corresponding integral equation from two-dimensional to one-dimensional, in which form it has two solutions most expediently obtainable by the quasi-solution process with appropriate corrections. Systematic calculations for a typical quasi-realistic experiment have yielded quite accurate results, on the basis of a solution very stable under perturbations simulating measurement errors. Figures 4; tables 1; references 24: 19 Russian, 5 Western.

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REGULATION ALGORITHMS FOR DIGITAL REGULATORS OF ELECTRIC DRIVES

Moscow SISTEMI AVTOMATICHESKOGO UPRAVLENIYA: EKSPRESS-INFORMATSIYA in Russian No 5, 1987 pp 12-17

[Article by R. Schönfeld, H. Krug, G. H. Geitner and A. Stoev in MESSEN-STEURN-REGELN in German (GDR) Vol 28, No 9, Sep 85 pp 390-394, translated by A. S. Belotserkovskiy]

[Abstract] A quasi-continuous algorithm of regulation is constructed on the basis of a difference equation as first-order approximation of the differential equation describing a continuous regulator. The quasi-continuous regulation is then optimized by making the quantization step sufficiently small. The regulation object consisting of a continuous part and a discrete one is represented by its transfer function, which includes time delays and gains. For the

specific case of an electric drive, generally without discontinuities, the regulator is converted to an aperiodic one with unit step and further to an aperiodic one with nonoscillatory control action, depending on the stringency of requirements. An optimum digital regulator is obtained by fully or partially compensating the numerator of the object's transfer function.

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MATHEMATICAL MODELING OF REFLECTION OF OPTICAL SIGNAL IN STOPE

Leningrad IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: PRIBOROSTROYENIYE in Russian
Vol 29, No 12, Dec 86 (manuscript received 3 Apr 86) pp 66-71

[Article by V. S. Alekhin, Donetsk]

[Abstract] Remote control of a combine for safe coal mining operation by means of an optical communication channel is considered, the signal reflected by the coal bed into the photoreceiver being essential to that control. A mathematical model is constructed describing formation of the reflected signal, which depends on the coal bed characteristics, and its subsequent propagation through the stope with further reflections along its path. On the basis of this model are determined the necessary photoreceiver characteristics, namely its irradiance pattern and sensitivity curve, minimum gain and maximum noise, as well as the appropriate photoreceiver location and orientation relative to a remote "point" source which will ensure coverage of the operating space under control. Figures 2; references 4: all Russian.

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CSO: 1862/134

CRITERION OF SINGULARITY IN GENERAL THEORY OF RELATIVITY

Tomsk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: FIZIKA in Russian Vol 30,
No 2, Feb 87 (manuscript received 24 May 85, after completion 23 Oct 85)
pp 94-99

[Article by M. Ye. Gertsenshteyn and Ye. Yu. Melkumova, Scientific Research
Institute of Nuclear Physics, Moscow State University imeni M. V. Lomonosov]

[Abstract] The problem of singularity in the general theory of relativity is analyzed, neither the classical Lifshits-Khalatnikov approach based on an analytical solution in the vicinity of a singularity nor the purely geometrical approach based on properties of time-like and isotropic geodesics being adequate. The conservative view is taken instead, based on validity of the equations of this theory everywhere and requiring a time-like range of material particles. The theorem about geodesics is geometrically demonstrated on a T-region of Schwarzschild metrics in vacuum, characterized by a full set of "geometrical hindrances" without physical curvature singularities. These are: convergence of the sequence of extendable geodesics to a nonextendable one, lack of continuity with respect to initial conditions on the Cauchy surface, and existence of slits which separate expanding and contracting T-regions. It is physically demonstrated on a physically realizable source, namely a charged dust sphere with a world-line boundary. A smooth manifold is assumed here and function C in the nondiagonal metrics $ds^2 = \tilde{\phi} dt^2 + 2\tilde{B} dt dr + C dr^2 - r^2 d\sigma^2$ ($c = 1$) without horizons at time $t = \infty$ is required to be continuous everywhere except for singularities arising from Reissner-Nordstrom solutions. It is subsequently shown that the proposed solution may be one without singularities of the infinite-density kind, with the gravitational field treated according to classical theory and matter is treated according to quantum theory. Only singularities of the infinite-density kind (density larger than the Planck density of $5 \cdot 10^{93}$ g/cm³) being of concern to physicists, existence of infinite density does not follow from the singularity criterion, namely from existence of non-extendable time-like geodesics. At finite density expansion replaces compression so that the equations of the general theory of relativity are satisfied without quantization of the gravitational field. This confirms that appearance of singularities implies possible breakdown of the general theory of relativity and that gravitational collapse renders all laws of physics meaningless. Figures 2; references 20: 13 Russian, 7 Western (6 in Russian translation).

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MASS OF NEUTRINO BASED ON β -SPECTRUM (IThPh-86)

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 6, 25 Mar 87 (manuscript received 13 Aug 86) pp 267-271

[Article by S. D. Boris, A. I. Golutvin, L. P. Laptin, V. A. Lyubimov, V. V. Nagovitsyn, V. Z. Nozik, Ye. G. Novikov, V. A. Soloshchenko, I. N. Tikhomirov and Ye. F. Tretyakov, Institute of Theoretical and Experimental Physics, and N. F. Myasoyedov, Institute of Molecular Genetics, USSR Academy of Sciences]

[Abstract] The latest series of measurements made at the Institute of Theoretical and Experimental Physics in 1986 have yielded the β -decay spectrum up to 5.5 keV and 10 times more additional statistics for the 1.7 keV wide principal fitting range so that the neutrino mass M_ν and the energy limit E_0 , taking into account the complete resolution function along with its optical component and ionization-loss component, can be determined with a systematic error 1.5 times smaller than before. Both parameters are estimated on the basis of 1983-86 measurements by fitting the data to a model spectrum. The results are compared with those based on the theoretical spectrum of finite states in a molecule of the source substance (valine) and during decay of tritium, with those based on the energy of electron shells in tritium and helium atoms, also with those based on the correlation trajectory in the $M_\nu^2 - E_0$ plane. Calculations made by the M. Fritshi group (Switzerland) in 1986 are criticized for overconfidence in their accuracy and for ignoring the high-energy tail of the loss curve in blatant contradiction to its experimentally established significance. Tables 2; references 16: 3 Russian, 1 East German, 12 Western.

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DISCOVERY OF THIN JETS IN HADRON-CARBON INTERACTIONS WITH 0.4 TeV MEAN ENERGY

Moscow PISMA V ZHURNAL EKSPERIMENTALNOY I TEORETICHESKOY FIZIKI in Russian
Vol 45, No 6, 25 Mar 87 (manuscript received 5 Feb 87) pp 264-267

[Article by N. G. Dzhaoshvili, D. M. Kotlyarevskiy and I. V. Paziashvili, Institute of Physics, GSSR Academy of Sciences]

[Abstract] Thin hadron jets were discovered in the TsKhRA-TsKARO-1 facility, in an experiment with multiple production during interaction of 0.1-2.0 TeV (average energy 0.4 TeV) hadrons in cosmic rays and a polyethylene target. Measurements were made with an 890 g/cm² thick Pb-Fe calorimeter, the error not exceeding 30% at the 400 GeV energy level. An analysis of the results of 50 interaction event, including estimates of NN events as well as of cross-sections for inelastic production of charged particles on carbon and on hydrogen, yields a close agreement with the results of previous experiments. The distribution of energy fluxes in the Θ, ϕ plane of polar and azimuthal track angles, charted for each event in the "incident hadron-target" centers of mass system,

reveals singularities in the distribution of momentum fluxes. As jets are regarded groups of at least three tracks within a spherical angle smaller than 36° and with jet particles satisfying two constraints. Noteworthy are smallness of the transverse momentum of particles in a jet relative to the jet axis and realization of a hadron-nucleus avalanche largely in the form of jet events. The authors thank N. N. Roinishvili, T. T. Barnaveli, S. D. Kananov, G. Z. Shtemanetyan, A. A. Tyapkin, Yu. G. Verbetskiy, Ye. G. Gurvich, E. V. Gedalin, O. V. Kancheli, I. I. Royzen and M. G. Ryskin for helpful discussions of experimental and theoretical aspects. Figures 3; tables 1; references 12: 11 Russian, 1 Western.

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RELATIVISTIC THEORY OF GRAVITATION AND NEW CONCEPTS ABOUT SPACE-TIME

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[Article by A. A. Logunov, Institute of High-Energy Physics]

[Abstract] Following an overview of Minkowski's and Einstein's modifications of Newtonian physics, along with Lobachevskiy's and Riemann's modifications of Euclidean geometry, the General Theory of Relativity is outlined with emphasis on departures from classical concepts in physics such as energy and momentum conservation as well as from the Faraday-Maxwell concept of a gravitational field. The subsequently developed relativistic theory of gravitation is then shown to satisfy those laws of conservation and to describe the gravitational field with a symmetric tensor. Geometrization is shown to connect this tensor to the metric Minkowski-space tensor, by virtue of the universality of gravitational field and matter interaction. Physical corollaries of this theory are prediction of a "latent mass" in the Universe with an energy density almost 40 times higher than that of known matter, explanation of all experimental data gravitational phenomena in the solar system, and new concepts about gravitational radiation. Predictions based on the general theory of relativity are shown to be arbitrary and intuitive rather than logical, Einstein's gravitational equations deriving rather from the relativistic theory of gravitation. The latter predicts, moreover, both evolution and gravitational collapse of a Friedman Universe. References 22: 7 Russian, 15 Western (3 in Russian translation).

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